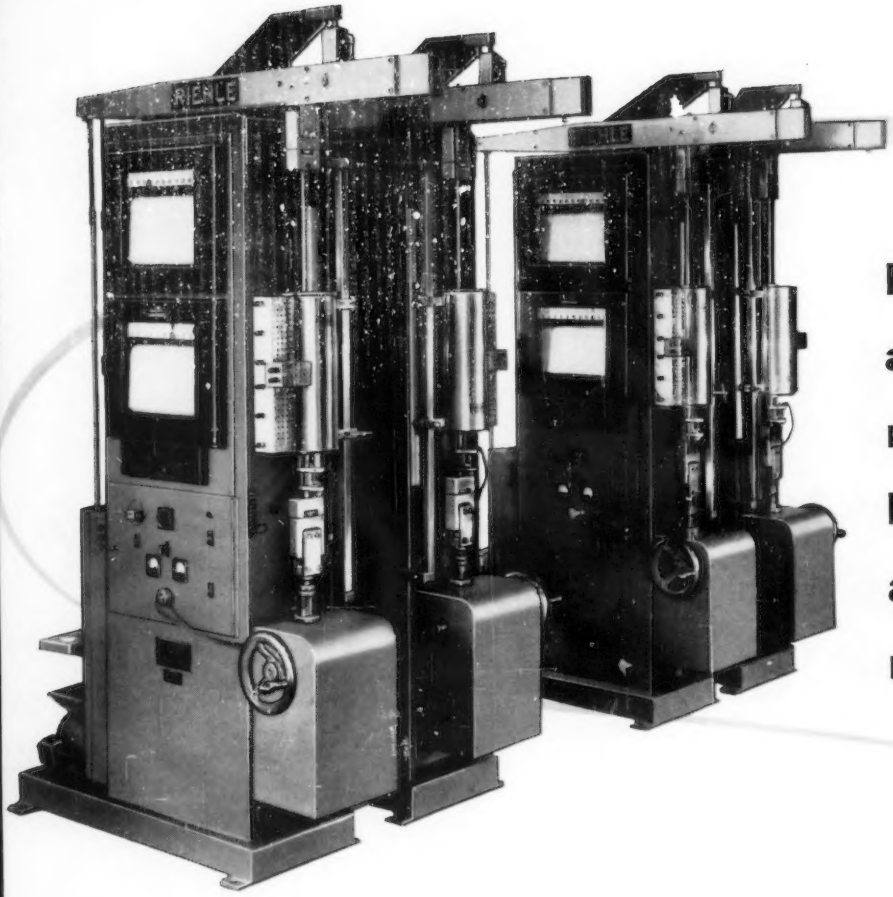
JULY 1956
No. 215

# ASTM Bulletin

PACIFIC AREA NATIONAL MEETING
September 17–21
LOS ANGELES
Hotel Statler

American Society for Testing Materials

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# ASTM BULLETIN

JULY 1956

Number 215

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## September 17-21, Hotel Statler, Los Angeles

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# ASTM BULLETIN

*"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"*

Number 215 July 1956

# *Second Pacific Area National Meeting ASTM's Biggest*

LOS ANGELES SEPTEMBER 17–21

TECHNICAL SESSIONS COMMITTEE MEETINGS INDUSTRY LUNCHEONS PLANT VISITS
APPARATUS EXHIBIT ENTERTAINMENT

VIEWED from many angles the Second Pacific Area National Meeting which convenes at Los Angeles' Hotel Statler, September 17–21, will be the largest the Society has ever held. In 43 technical sessions and symposiums, members and guests will hear and discuss 210 papers covering a tremendous range of materials research and technology.

The National Luncheon, at which General C. S. Irvine, USAF, will speak and the seven industry luncheons which will be addressed by industry leaders, will provide an unprecedented number of nationally known speakers.

An extensive plant visits program and a ladies' entertainment program that covers the area's many attractions have been planned by the hard working Committee on Arrangements, to whose members goes a great deal of the credit for the development of this outstanding meeting.

A summary page of the week's main activities and details of other events of the meeting appear on the following pages.

## Technical Program

The most extensive technical program ever sponsored by ASTM is the result of intense efforts on the part of the symposium chairmen, the sponsoring technical committees, and the numerous authors under the guidance of the Pacific Area Program Committee and the Society's Administrative Committee on Papers and Publications.

The great diversity of the technical program can be seen from a glance at the subjects of the sessions:

**Turbine Oils**
**Plastics**
**Titanium**
**Road and Paving Materials**
**Ferrous Metals**
**Nondestructive Testing**
**Railroad Materials**
**Soils**
**Wood Poles**
**Lubricating Oils**
**Full Scale Tests on House Structures**
**Properties, Tests, and Performance of Electrodeposited Metallic Coatings**
**Building Design for Seismic Shock Loading**
**Masonry**
**Developments in Glued-Laminated and other Wood Constructions**
**Vapor-Phase Oxidation of Gasoline**
**Structural Sandwich Constructions**
**Radiation Effects of Materials**
**Non-Ferrous Metals**
**Concrete**
**Industrial Water and Waste Water**
**Cement**
**Paint**
**Radioactive Isotopes**
**Fatigue**
**Wood for Marine Use and Its Protection from Marine Organisms**

## Plant Visits

There are 17,000 industrial plants within a 100-mile radius of Los Angeles, a number of them new industries, others offering the most advanced facilities and techniques to be found in this country. Visits to a selected list of representative laboratories and plants in the vicinity will be arranged on an individual or small group basis by the Plant Visits Committee. They will supply the Information Desk with all needed information on hours, groups, transportation, appointments, and special arrangements. Companies that have invited visitors are:

**Consolidated Rock Products**—concrete aggregates
**Livingston Rock and Gravel Co., Inc.**
**Industrial Asphalt Co.**
**Douglas Aircraft**
**J. H. Baxter & Co.**—wood treatment
**Summerbell Roof Structures**—glued laminated timber products
**City of Los Angeles Department of Water and Power**—water quality control laboratory
**American Gas Assn.**—testing laboratory
**Rome Cable Corp.**—novel method of manufacturing rigid conduit
**Consolidated Western Steel**
**U. S. Steel Columbia-Geneva Div.**
**Kopper Co., Inc.**—tar and chemicals
**Kaiser Steel Corp.**
**Bethlehem Pacific Coast Steel Corp.**
**Beckman Instruments Inc.**—scientific and data handling equipment
**California Research Corp.**—oil field research and development
**Richfield Oil Corp.**—research and development laboratories
**Shell Chemical Corp.**—only completely integrated synthetic rubber plant in U.S.
**Union Oil Co.**—research center
All Los Angeles members of the **American Council of Independent Laboratories, Inc.**

*This Program Is Subject to Change*

# PROVISIONAL PROGRAM

# *Pacific Area National Meeting*

## AMERICAN SOCIETY FOR TESTING MATERIALS

*LOS ANGELES, CALIF. • SEPTEMBER 17—21, 1956*

| MONDAY, Sept. 17 | TUESDAY, Sept. 18 | WEDNESDAY, Sept. 19 | THURSDAY, Sept. 20 | FRIDAY, Sept. 21 |
|---|---|---|---|---|
| **MORNING** | | | | |
| Opening Session<br>Symposium on Turbine Oils<br>Plastics Session<br>Miscellaneous Session<br>Symposium on Titanium<br>Committee Meetings | Symposium on Railroad Materials<br>Soils Session<br>Symposium on Wood Poles<br>Symposium on Nondestructive Testing<br>Titanium Session<br>Committee Meetings | Symposium on Properties, Tests and Performance of Electrodeposited Metallic Coatings<br>Soils Session<br>Symposium on Building Design for Seismic and Shock Loading<br>Symposium on Railroad Materials<br>Session on Masonry<br>Committee Meetings | Symposium on Structural Sandwich Constructions<br>Symposium on Radiation Effects on Materials<br>Non Ferrous Materials Including 1956 Gillett Lecture<br>Session on Concrete<br>Symposium on Industrial Water and Industrial Waste Water<br>Committee Meetings | Symposium on Radioactive Isotopes<br>Symposium on Paint<br>Fatigue Session<br>Symposium on Wood For Marine Use and its Protection From Marine Organisms<br>Committee Meetings |
| **LUNCHEONS** | | | | |
| Petroleum Industry Luncheon | Soils Industry Luncheon<br>Wood Industry Luncheon<br>Railroad Luncheon | President's National Luncheon | Industrial Water Industry Luncheon<br>Cement and Concrete Industry Luncheon<br>Paint Industry Luncheon | |
| **AFTERNOON** | | | | |
| Symposium on Turbine Oils<br>Session on Road and Paving Materials<br>Ferrous Session<br>Nondestructive (Report on Activities of Committee E-7)<br>Symposium on Titanium<br>Committee Meetings | Soils Session<br>Symposium on Lubricating Oils<br>Symposium on Full-Scale Tests on House Structures<br>Symposium on Nondestructive Testing<br>Committee Meetings | Symposium on Properties, Tests and Performance of Electrodeposited Metallic Coatings<br>Symposium on Developments in Glued-Laminated and other Wood Constructions<br>Symposium on Vapor Phase Oxidation of Gasoline<br>Committee Meetings | Session on Cement<br>Symposium on Industrial Water and Industrial Waste Water<br>Symposium on Radiation Effects of Materials<br>Paint (Report on Activities of Committee D-1)<br>Symposium on Structural Sandwich Construction<br>Committee Meetings | Symposium on Radioactive Isotopes<br>Symposium on Paint<br>Fatigue Session<br>Committee Meetings |

## Program Changes

THE technical program for the meeting to be held at Los Angeles remains practically unchanged from that published in the preliminary program mailed to members and committee members in June. The only important changes which should be noted are these:

The title of the *Symposium on Turbine Oils* has been changed to *Symposium on Steam Turbine Oils.*

The paper "Occurrence and Significance of Vapor Phase Oxidation in Army Engine," by N. L. Klein has been withdrawn from the *Symposium on Vapor Phase Oxidation of Gasoline.*

"New Methods for Handling Plating Wastes" by W. S. Morrison withdrawn from *Symposium on Industrial Water.*

"An Evaluation of Isotopes in Industrial Radiography" withdrawn from the *Symposium on Nondestructive Testing.*

"Structural Paper Honeycomb Panels" by N. A. Lombard and "Sandwich Structures in Naval Construction" by W. R. Graner are withdrawn from *Symposium on Structural Sandwich Constructions.*

## President's and Industry Luncheons

### President Schatzel; General Irvine, United States Air Force; and Industry Leaders to Speak

In addition to the President's National Luncheon scheduled for Wednesday, September 19, seven other Industry Luncheons will be held during the Pacific Area National Meeting. We are particularly pleased to announce that the chief speaker and honored guest at the National Luncheon will be Lt. General Clarence Irvine, Deputy Chief of Staff (Materiel), United States Air Force. In view of Society's concern with so many of the materials going into the Air Force supply field and the concentration of this industry in California, General Irvine, a forceful speaker, will have an appropriate message for the large audience expected. He accompanied General Twining on the recent trip to Russia.

To each luncheon will be invited leading executives and technologists, both from within and without the membership of the Society. These luncheons will provide an opportunity for the executives and technical men with similar interests to meet one another and to hear an authoritative discussion by a leader in the field. Prof. Woods will discuss the subject, "Use of Explorations and Tests for Design of Pavements and Structures." Dr. Bates is expected to highlight some significant phases of research, and Dr. Schrader's talk will cover "Increasing Integration in the Manufacture of Forest Products."

A special mailing to the members will give a complete list of speakers and their topics. Advance reservations for the luncheons will be made available. Members will find it worth while to attend.

A list of the luncheons and speakers follows:

*Monday, Sept. 17*

| | |
|---|---|
| **Petroleum** | To be announced |

*Tuesday, Sept. 18*

| | |
|---|---|
| **Soils** | **K. B. Woods,** ASTM Junior Vice-President and head of the School of Civil Engineering, Purdue University. |
| **Wood** | **O. Harry Schrader, Jr.,** general manager (Washington Division) United States Plywood Corp. |
| **Railroad** | **J. W. Corbett,** vice-president (Systems Operations), Southern Pacific Co. |

*Wednesday, Sept. 19*

| | |
|---|---|
| **President's National Luncheon Honoring R. A. Schatzel** | **Lt. Gen. Clarence S. Irvine** |

*Thursday, Sept. 20*

| | |
|---|---|
| **Industrial Water** | **Claude K. Rice,** coordinator, Gulf Oil Corp., and ASTM Standards Advisor. |
| **Cement & Concrete** | **A. Allan Bates,** ASTM Director, and vice-president for research and development, Portland Cement Assn. |
| **Paint** | **Clyde L. Smith,** president, Federation of Paint & Varnish Production Clubs, and President, Vi-Cly Industries, Inc. |

General Irvine

K. B. Woods

O. H. Schrader

J. W. Corbett

C. K. Rice

A. A. Bates

C. L. Smith

## Information Desk

The tenderfoot from the East will be able to find out all about the meeting and Los Angeles from the ASTM Information Desk at the Statler. The information committee will be prepared to tell him what to do and see, and how to get there. They will be able to supply a list of the best restaurants in the area and the specialties of the house. For those who are combining their vacation with attendance at the meeting they will be prepared to answer specific questions about vacation opportunities and travel.

This desk is a fine service. Be sure to use it.

## Ladies Entertainment

While the men are attending the sessions, luncheons, and committee meetings, their wives and children will have an unusually good (and inexpensive) opportunity to see some of the most interesting and attractive features of the Los Angeles area. The ladies' events are scheduled as follows:

**MONDAY**—"Get Acquainted Breakfast" at the Statler with a Hollywood columnist and chitchat about the stars

**TUESDAY**—Disneyland—a bus trip to the fabulous amusement park

**WEDNESDAY**—Luncheon on the Ship Deck of the Sheraton—Huntington Hotel in Pasadena, the world famed Huntington Library, the beautiful estates of Pasadena, the Rose Bowl

**THURSDAY**—A coastline drive to Marineland, world's largest oceanarium, lunch at Marineland Restaurant, a cruise in Los Angeles harbor

**FRIDAY**—Wilshire Boulevard to a tour of a major film studio—a fashion brunch at the Beverly Hills Hotel and home through Beverly Hills and the homes of the stars.

## In and Around Los Angeles

And for whatever spare time you may find aside from the technical sessions and entertainment planned, there are many spots of interest to visit in and around Los Angeles.

**Catalina Island**—Fabulous, romantic Santa Catalina Island lies 25 miles off the mainland—"close at hand yet far from care." May be reached by steamer from Wilmington or by air from Long Beach Airport.

**Grauman's Chinese Theatre**—Intended to represent an oversized oriental pagoda, the theater is internationally famous for its forecourt where concrete slabs have captured the footprints, handprints, and signatures of the movie stars of yesterday and today.

**Columbia Broadcasting System (CBS)**, Columbia Square, Sunset Blvd. near Vine—Many things to see here including the CBS Playhouse where the Lux Radio Theatre and other programs are presented. For program and ticket information, telephone the studios.

**Disney Studios,** Burbank—The only studios where the stars are really "out of this world."

**Farmers' Market,** Northeast corner of Third St. and Fairfax Ave.—This is like nothing you have ever seen—one of the most unique and fascinating shopping centers in Southern California. The Farmers' Market is a habit with native Angelinos and is a treat no visitor should miss. Open from 10 a.m. to 6 p.m.; closed Sunday.

**Forest Lawn Memorial Park,** Glendale—Three hundred acres of rolling, green, landscaped hills dotted with ponds, trees, flowers, chapels, and statuary in the classic tradition. Forest Lawn each year receives twice as many visitors as the Metropolitan Museum of Art in New York City. It is the only place in the world where exact, full-sized marble reproductions of the greatest work of Michelangelo have been gathered together in one place. In the Mausoleum is the world-famous Last Supper Window—a full-sized stained glass reproduction of the painting by Leonardo da Vinci—admission to the window by card only. Cards may be obtained by telephoning Forest Lawn. Forest Lawn possesses the largest religous painting in the world—Jan Styka's "Calvary"—195 feet long and 44 feet high, with 1000 life-size figures.

**Griffith Observatory and Planetarium,** Griffith Park—Situated atop one of highest points in Griffith Park, the observatory and planetarium are a must for the sight-seer, the star gazer, and the scientifically minded.

**Hollywood Bowl**—Located high above the city and surrounded by the yucca-dotted hills of Hollywood, is the largest natural amphitheater in the world. In this 59-acre bowl seating more than 20,000 and accommodations for more on the hillside music lovers can see and hear the world's greatest artists for less than a dollar in programs ranging from Bach to ballet.

**Kellogg Arabian Horse Ranch,** on U. S. Highway 99 a few miles west of Pomona—Presented to the University of California, Institute of Animal Husbandry, by William H. Kellogg, the Michigan cereal magnate, the ranch is used for breeding and experimentation and contains some of the finest Arabian horses in the world. With free admission, it is open from 9 to 5 daily; and on Sunday afternoons there are special showings of trained horses for a nominal admission charge.

**Laguna Beach,** 49 miles south of Los Angeles on U. S. 101-A—Sometimes called the American Riviera, Laguna Beach with its craggy cliffs, sloping, sandy beaches, and dazzling blue water has become a favorite home for writers and artists. High on a hilltop in South Laguna may be seen the fabulous "Hangover House" built by Richard Haliburton.

**Mission Inn,** 58 miles east of Los Angeles in Riverside—One of the most famous hostelries in the civilized world. Beautifully proportioned in Spanish Colonial style and located in the heart of the orange empire.

**Mount Wilson Observatory,** 30 miles northeast of Los Angeles on Mount Wilson—Famous for its 100-inch telescope, the observatory includes several other telescopes and a vast technical library and research department containing nearly 25,000 volumes. Visitors are admitted to the telescope free from 2 p.m. to 4 p.m. Monday through Friday; 11 a.m. to 4:30 p.m. Saturday, Sunday, and holidays. Lectures are given each evening at 7 p.m.

**Motion Picture Studios**—Visitors in Los Angeles are always interested in seeing Hollywood and the studios where motion pictures are made. The studio buildings and grounds are interesting in themselves and those who get there early may watch the stars driving through the gates on their way to work. The Ladies' Entertainment Program provides for a trip through one of the studios.

**San Gabriel Mission,** 314 Mission Dr., San Gabriel—One of California's many Franciscan missions founded in 1771. The mission has been reconstructed on the interior. The two cocoanut palms in the yard planted by the mission fathers were the first to bear fruit in this country. Nearby is the famous Mother grapevine, the largest and oldest grapevine in the world.

**University of California at Los Angeles** (UCLA), Westwood Village—A beautiful 334-acre expanse of rolling green lawns and heavily wooded hills on which are scattered the beautiful terra cotta and tile buildings of UCLA. The University is a branch of the parent University of California in Berkeley.

**University of Southern California** (USC), University Ave. between 34th St. and Exposition Blvd.—One of the largest and most well-known colleges in the Los Angeles area, privately-endowed, nonsectarian, coeducational. At the corner of University Ave. and 36th St. stands the symbol of the University of Southern California—an 8-foot statue of a Trojan warrior on a 10-foot pedestal.

**Rose Bowl,** North Arroyo Blvd., Pasadena—Famed for its East-West Rose Bowl games played each Near Year's day. The bowl seats 90,000 and is surrounded by extensive flower-and-shrub-planted grounds. The bowl and its gardens are open to the public except when in use.

**Disneyland**—Located 25 miles southeast of Los Angeles is the magic kingdom created by Walt Disney that over 2,000,000 persons have visited since its opening. Here, you may turn back the clock 50 years to look down the "heartline of America" as it appeared at the turn of the century. Main street itself is a replica of a typical street of a small town in America about 1900. The Emporium is busy with shoppers who are actually making purchases. Tomorrowland where a swift time transition takes place and the calendar rolls ahead to 1986. "Circarama" showing movies on a 360-degree screen. Then there is "Nautilus," Captain Nemo's submarine in "20,000 Leagues Under the Sea." You enjoy an exciting and scientifically accurate ride in the TWA Rocket to the Moon on its simulated journey through space. Fantasyland, King Arthur's Carrousel, Frontierland, Adventureland and it is all for you to see and enjoy. There is much of interest for everyone old and young.

**Olvera Street**—One of the oldest streets in the city, "El Paseo de Los Angeles," is preserved as a replica of a Mexican street of a century ago. Mexican festivals are held here.

**Exposition Park**—In the center of the park is the sunken garden, a 7-acre plot containing 15,000 rose bushes of 120 varieties. The 1932 Olympic Games were held in the Los Angeles Memorial Coliseum, a great oval 1065 feet long and 763 feet wide. The California State Exposition Building, also in the park, has exhibits and dioramas showing the resources, industries, and recreational facilities of California. Near the sunken garden is the Los Angeles County Museum of History, Science and Art. It houses reconstructed skeletons of prehistoric birds and animals obtained from La Brea Fossil Pits.

**Los Angeles Ostrich Farm**—Here ostriches are raised for their feathers and to supply zoos and motion-picture studios.

**California Alligator Farm**—Adjoins the Ostrich Farm with hundreds of alligators of all sizes and ages. Special exhibitions of trained alligators are presented.

## The Weather?

SHOULD be perfect. Meteorological records of the past ten years for the week of September 16 in Los Angeles showed rain on only one day—all of 0.01 in. Temperatures generally ranged in the delightful middle 70's.

# 59th Annual Meeting

## High-Caliber Technical Program Draws Record Attendance in Atlantic City

WHAT MAKES up an Annual Meeting? Obviously the answer is many things: attendance, quality of program, number and character of sessions, the committee meetings, the competent handling of sessions by the presiding officers, but, above all, enthusiasm, on the part of the participants. From every point of view the recent Annual Meeting held in Atlantic City was a most successful one, and in addition to the several factors referred to above, the very extensive apparatus exhibit added not a little to the interest and value of the meeting. The record attendance was close to 2900, by far the highest to date. The technical sessions, while not any greater in number, were by and large very well attended with capacity audiences for the two lectures and for the four technical sessions comprising the solder symposium which if anything was the highlight of the meeting. Presiding officers almost without exception conducted the sessions so as to have brisk and interesting presentations and in order to draw out questions and discussion from the audience. The technical committee meetings were as numerous as usual with over 700 being held during the week with excellent attendance and participation. On every hand were heard enthusiastic comments both with respect to the nature of the sessions and the work accomplished in committees.

Some of the features of the meeting are discussed below, as for example, the lectures and the President's Luncheon as well as some few of the technical sessions. There is also some reference to committee work both with respect to that reported upon at the Annual Meeting sessions and that which transpired at the committee meetings. The standards recommendations presented to the meeting on which action was taken are summarized in tabular form together with a list of new and extensively revised tentatives (page 28).

No attempt is being made to give complete coverage of the sessions either by way of reporting details of actions taken on recommendations on standards or listing the many papers presented. The latter would be essentially a duplication of the program appearing in the April issue of the BULLETIN. All of the items will be mentioned in the Summary of Proceedings and notices of the availability of the papers in published form will be given in the BULLETIN as the several Special Technical Publications appear.

### New Officers

RUDOLPH A. SCHATZEL, vice-president and director of engineering, Rome Cable Corp., was elected president for 1956–1957, succeeding Claire H. Fellows, director of the Engineering Laboratory and Research Department of the Detroit Edison Co., who continues on the Board of Directors for three years.

KENNETH B. WOODS, head of the School of Engineering, and director of the Joint Highway Research Project, Purdue University, was elected vice-president for a term of two years.

The new members of the Board of Directors, serving three-year terms, are:

M. N. CLAIR, president, The Thompson and Lichtner Co., Inc., Brookline, Mass.

H. C. CROSS, metallurgist, Battelle Memorial Institute, Columbus, Ohio.

G. H. HARNDEN, consultant, materials and processes, Engineering Standards Service, Engineering Services Div., General Electric Co., Schenectady, N. Y.

R. R. LITEHISER, engineer of tests, Ohio State Highway Testing Laboratory, Columbus, Ohio.

C. R. STOCK, group leader, Physical Measurements Group, American Cyanamid Co., Stamford, Conn.

These new officers, together with R. T. Kropf, vice-president and director of research, Belding Heminway Co., Inc., New York City, who is senior vice-president of the Society, and ten other members of the Board elected in the two previous years, will constitute the 1956–1957 officers.

Incoming President Schatzel

### Marburg Lecture

### *Reed discusses silicones*

CHARLES E. REED of General Electric Co., is general manager of one of the earliest plants to produce silicones commercially. A background of research experience enabled the lecturer to be intimately connected with the inception and growth of this organic-like structure.

Silicones are materials which extend the useful range of organic materials. Their expansion into new areas of utilization provided the basis for this 30th Edgar Marburg Lecture.

Carefully illustrated was the fact that, chemically speaking, silicones are constructed and synthesized much like their organic cousins. The point of departure lies in the strength of the silicone binding forces. This difference in bond strength accounts for its ability to withstand high temperature without decomposition, its chemical inertness to metals and most reagents, and a very low coefficient of viscosity with temperature.

Silicones may be cross linked to form two-dimensional molecules. Such products have found a wide variety of uses due to their excellent dielectric properties, good temperature stability, and chemical inertness.

Further cross linking will form three-

President Fellows expresses the Society's appreciation to Marburg Lecturer Charles E. Reed.

dimensional networks of insoluble, infusible elastomers. Data showing chemical and physical properties of these silicone rubber and plastic-like materials were given and illustrations of outstanding uses were displayed.

In concluding the lecture, Mr. Reed demonstrated a few of the spectacular range of properties of silicones: Antifoaming—a head of good beer reduced to the vanishing point in a few moments. Bouncing putty—a silicone having most peculiar rheological and elastic properties. Reed reviewed some of the more distressing properties that bouncing putty exhibits in the home and noted a free publication on the subject—how to get bouncing putty out of your hair.

### Gillett Lecture

## *Crampton on microstructure of copper*

THIS was the fifth in the series of Gillett Lectures devoted to subjects pertaining to the development, testing, evaluation, and application of metals. It appropriately brings in a field not heretofore covered, namely, that of copper. The lecturer, D. K Crampton, director of research and development, Chase Brass & Copper Co., Inc., Waterbury, Conn., has a long background of work in this field and was excellently equipped to present a most interesting and instructive lecture on the "Structural Chemistry and Metallurgy of Copper." Dr. Crampton developed the subject in a very fundamental manner and in doing so explored three aspects of microstructure of copper.

The first portion covered some new work on recrystallization and grain growth of copper alloys, investigating time intervals much shorter than those used heretofore. In the second portion, the lecture dealt with the structural chemistry of copper and copper alloys and more particularly the relation of grains and grain boundaries both in pure copper and some copper alloys. Lastly, Dr. Crampton described some new investigations of the fundamentals of corrosion and corrosion resistance of copper and some of the factors affecting the incidence growth of corrosion pits.

The lecture was profusely illustrated and held the interest of the audience throughout.

D. K. Crampton, the Gillett Lecturer.

### Solder Symposium

## *Four lively sessions crowded*

A BRIEF introduction by Bruce W. Gonser of Battelle Memorial Inst. opened the Solder Symposium which developed into just about the liveliest four sessions of the Annual Meeting. The sixteen papers presented covered the field from manual soldering to ultrasonic techniques, all to the apparent satisfaction of the audience which numbered as high as 500 for some sessions. G. H. Harnden of the General Electric Co. assembled a symposium that will rank as a notable contribution to the field of soldering. The vigorous discussion following each paper attested to the wide interest this symposium had aroused.

E. Miller of Eastman Kodak Co., described mechanized techniques for economically obtaining strong, stable, dip-soldered joints of printed circuits while W. H. Rombach, of the Philco Corp., in speaking on controlling quality of soldered electrical connections illustrated the problems of control in manual soldering operations. The dip-soldered joint was evaluated from four angles by A. A. John, of Eastman Kodak, who investigated (1) the efficiency of joint formation, (2) short-time tensile strength, (3) tensile impact, and (4) creep strength in tension. This investigation provides insight into production problems and makes available large amounts of design data for printed circuit dip soldering.

The papers in this symposium clearly illustrated that the problem of soldering involves several branches of science including chemistry, physics, and metallurgy. Successful soldering is an art explained A. Z. Mample, Western Union Telegraph Co., in his paper on fluxes. "It is an art that requires consideration and evaluation of the solder metal, flux, temperature, quantity of heat and application, type and condition of surfaces involved and service requirements. The present practice seems to be to concentrate on one factor which usually happens to be the particular phase of the problem." Mample explained the difficulties that are likely to develop when even one of these factors is ignored.

The history of rosin base fluxes was reviewed by F. C. Disque, Jr., of Alpha Metals, Inc., who pointed up the need for a better understanding of the types available and their advantages and disadvantages. He showed the need for more information on corrosion and to what extent it is a problem with fluxes. In the same vein H. C. Sohl, American Smelting and Refining Co., evaluated the corrosive tendencies and spread of activated rosin residues; and H. M. MacIntosh, Tin Research Inst., Inc., covered corrosive fluxes and their role in soldering.

In his investigation of "tin disease," A. Bornemann, Stevens Inst. of Technology, showed that alloying with small quantities of bismuth and antimony provides an effective cure of the tendency of the tin in solder alloys to transform (from stable to gray) under low-temperature storage conditions. In line with this, W. L. Williams, of the U. S. Engineering Experimental Station, dealt with the possibility of joint deterioration from the transformation of white to gray tin at low temperatures. He pointed out that this transformation of tin can occur in soldered joints in much the same way that it can occur in bulk solders.

The literature will be enriched by the publication of this extensive symposium. Many gaps in our information are being filled. On the subject of paste solder alloys, there is a lack of published literature. As a result, considerable confusion has developed which has hindered progress in this field. The

paper by H. R. Williams, "Industrial Survey of Paste Solder Alloys" correlates much of the scattered data as the nucleus for future standardization for industrial use. Williams, of Fusion Engineering, also pointed up the need for some standardization and identification system for both physical and chemical properties of paste solder alloys in line with the generally accepted practice for bar and wire solder.

The need for standards was further emphasized by L. Pessel, of the Radio Corp. of America, who illustrated a system for evaluating solders, fluxes, and solderability on the basis of a numerical scale rather than by descriptive qualitative terms. The system proposed by Pessel shows significant correlation with practical performance. It may prove generally useful in advancing soldering technology.

W. L. Lootens, of the General Electric Co., explained the problems involved in soldering semiconductor devices and showed how this could be accomplished without the use of flux. An investigation by H. E. Pattee, of the Battelle Memorial Inst., on some properties of soft solder at elevated temperatures and pressures was designed to assist manufacturers of automotive radiators, but it is also of great interest to others contemplating using soft solders at elevated temperatures.

For aluminum soldering, J. D. Dowd, Aluminum Company of America, described several applicable methods such as rub soldering, ultrasonic soldering, and reaction-flux soldering. The choice depends on the shape of parts, design of joints, service requirements, and economy.

Ultrasonic techniques permit soldering of aluminum without the use of any fluxes, thus eliminating corrosion attack resulting from flux residue or inadequate cleaning after soldering. This was demonstrated by J. G. Thomas, of Aeroprojects, Inc., who also described ultrasonic soldering equipment available for a broad range of applications.

A method for testing and evaluating the joint properties of a copper liner soldered in an aluminum casting was proposed by M. V. Davis of Anderson Electric Corp. As described in the paper, this method measures the strength of solder bond between a copper liner and the aluminum casting used for making bimetallic electrical conductor connections. It provides an empirical quantitative measurement of the joint strength of the solder bond. Test results obtained from daily production samples were subjected to quality control analysis.

The work presented here was neatly tied together by G. Harnden in his symposium summation. He cited the authors for bringing the field up to date with this latest research, and encouraged further work in the light of the ideas advanced at this symposium.

This Symposium on Solder will be available as a special technical publication the early part of 1957.

### Metals Sessions

## Brittle skin effect on ductility explored

DATA on mechanical properties of materials ranging from irradiated zirconium used as reactor-core structural material to highly alloyed superstrength alloys in the form of helical compression springs were made available to industry in a highly interesting technical paper session.

Of the six papers, the one evoking most interest was "The Effect of Brittle Skins on the Ductility of Metals" delivered by G. W. Form, École Polytechnique, Montreal. W. M. Baldwin, Jr., Case Institute of Technology, was co-author of this paper. The literature contains many references to this problem, all of which suggest that a brittle skin is capable of embrittling a metal out of all proportion to the percentage of the bulk that the skin itself occupies. The results presented in the paper strongly suggest that a brittle skin on an otherwise ductile material is essentially equivalent to the introduction of a "potential" notch into the metal.

A discussion by R. E. Richsecker and T. S. Howald, of the Chase Brass and Copper Co., pointed out the real interest of the copper industry in this work. The quantitative valuation of the effect of hydrogen embrittlement on loss of ductility and the profound effect of plated skins on subsequent ductility of the base metal is very important in the manufacture of parts made from copper and copper alloys.

## A method for obtaining actual rate of strain hardening

WHILE ALL the papers in another metals session presented data which will prove very useful in future investigations of the properties of metals, the paper on "The Effects of Strain Rate and Temperature on the Stress-Strain Relationships of Deep-Drawing Steel" gave some very interesting information on guides for evaluating deep drawing and stretching characteristics. R. J. McDonald of the Clevite Research Center, presented this paper which was prepared in conjunction with R. L. Carlson, Battelle Memorial Inst., and W. T. Lankford, U. S. Steel Corp.

No single laboratory test has yet been devised that gives completely adequate indices of the properties that determine

(*Continued on page 14*)

SUMMARY OF ACTIONS TAKEN AT 1956 ANNUAL MEETING AFFECTING STANDARDS AND TENTATIVES.

| | New Standard and Existing Tentatives Adopted as Standard | Standards in Which Revisions Will Be Adopted | New Tentatives | Revisions of Standard and Reversions to Tentative | Tentative Revisions of Standards | Existing Tentatives Revised | Standards and Tentatives Withdrawn |
|---|---|---|---|---|---|---|---|
| A. Ferrous Metals—Steel, Cast Iron, Wrought Iron, Alloys, etc. | 14 | 11 | 8 | 1 | ... | 28 | 2 |
| B. Non-Ferrous Metals—Copper, Zinc, Lead, Aluminum, Alloys, etc. | 8 | 14 | 7 | ... | ... | 29 | 2 |
| C. Cement, Lime, Gypsum, Concrete and Clay Products | 29 | 17 | 9 | 3 | 3 | 14 | 2 |
| D. Paints, Petroleum Products, Bituminous Materials, Paper, Textiles, Plastics, Rubber, Soap, Water, etc. | 61 | 30 | 49 | 8 | 10 | 40 | 3 |
| E. Miscellaneous Subjects, Testing, etc. | 9 | 3 | 10 | 1 | 1 | 7 | 1 |
| F. Electronic Materials | 3 | ... | ... | ... | ... | 3 | ... |
| Total | 124 | 75 | 83 | 13 | 14 | 121 | 10 |

## Apparatus Exhibit an Important Educational Part of the Meeting

EXHIBITORS had many new developments in research and testing apparatus to show in the ASTM Exhibit of Testing and Scientific Apparatus and Laboratory Supplies. A very large proportion of the apparatus displayed is specified in ASTM standards. However, many items were new or in the development stage and are likely to be incorporated eventually in ASTM test methods. The Exhibit served an important educational and scientific purpose by enabling visitors to see at first hand many of the items useful to them in their work, and take home with them as practical and forward-looking scientists ideas of ways of simplifying laboratory efficiency, cutting costs, and improving results, reproducibility, accuracy, and convenience.

Among the important trends noted at the Exhibit were a considerable increase in apparatus and applications in nondestructive testing, especially with the use of radioactive isotopes; testing of the physical properties of materials at very high temperatures; and automatic cycling of load sequences in fatigue testing.

Many exhibitors had the satisfaction which comes from having a solution to a problem which some of the visitors had been studying for a long time. Among the many new items on display were: small-scale apparatus known as Minilab; gamma radiography machines; a new lever-type creep testing machine; ultrasonic equipment for measuring thickness; microscopes; torsion balances; automatic polisher for metallographic specimens; microhardness testers; apparatus for laboratory analysis of gases and volatile liquids; vapor pressure apparatus for organic liquids; guarded hot plates for thermal conductivity measurements; abraders for determining resistance to abrasion; new industrial X-ray film; small particle detector; thickness gages; a new thermo regulator accurate to $\frac{1}{100}$ C for controlling electrically heated baths, ovens, etc.; instruments for measuring dielectric properties; petroleum testing apparatus; table model tension and compression testing machines; high-frequency induction furnaces; new type potentiometers; new model induction units for carbon and sulfur determination; precision balances; X-ray machines for nondestructive testing; radiation detection monitors; universal testing machines; a new inverted oxygen bomb; a new viscometer incorporating developments resulting from many years' experience; and new instrument features applied to standard instruments.

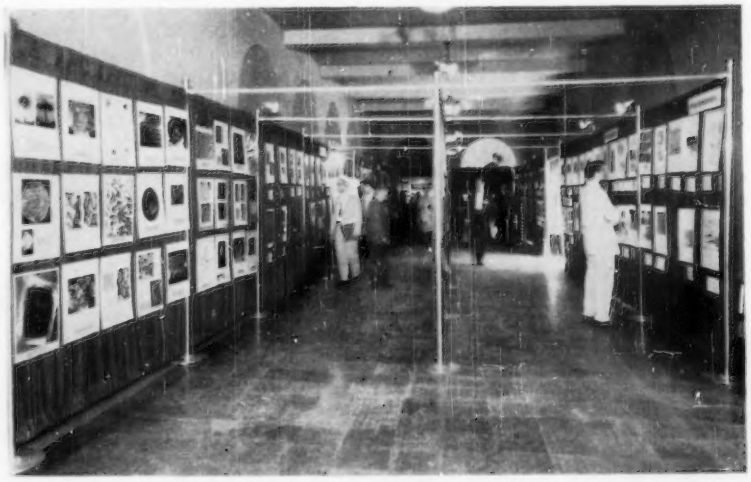
Of particular interest was the exhibit of the ASTM Advisory Committee on Corrosion which is responsible for correlation of all atmospheric exposure test site facilities which have been provided for ASTM technical committees. Test specimens and panels for a variety of metals and protective coatings were on display together with photographic records in black and white and kodachrome of exhibit panels and test sites.

The National Bureau of Standards had an interesting display of its standard samples for quality control of many industrial products and precision chemical analyses. Live demonostrations of standards of radioactivity and the $Hg^{98}$ lamp were of particular interest.

There was a special exhibit for one day only of the Bendix-Friez Lumicon for Industrial fluoroscopic inspection. Due to the characteristics of the machine it had to be installed in a room at the hotel away from other exhibits for the protection of visitors.

A complete list of exhibitors follows:

Ace Glass Inc.
American Cystoscope Makers, Inc.
ASTM Advisory Committee on Corrosion
Holger Andreasen, Inc.
Atlas Electric Devices Co.
Atomic Energy of Canada Ltd.
Baldwin-Lima-Hamilton Corp.
Bendix Aviation Corp.
Branson Instruments, Inc.
C. A. Brinkmann & Co.
Buehler Ltd.
Burrell Corp.
Central Scientific Co.
Curry & Paxton, Inc.
Custom Scientific Instruments, Inc.
Doble Engineering Co.
Eastman Kodak Co., X-Ray Division
Encyclopaedia Britannica
Fisher Scientific Co.
General Electric Co.
General Laboratory Supply Co.
General Radio Co.
The Emil Greiner Co.
Karl Heitz, Inc.
Instron Engineering Corp.
Laboratory Equipment Corp.
Leeds & Northrup Co.
Lindberg Engineering Co.
Mettler Instrument Co.
National Bureau of Standards
National Forge & Ordnance Co.
North American Philips Co., Inc.
Tinius Olsen Testing Machine Co.
Parr Instrument Co., Inc.
Picker X-Ray Corp.
Research Appliance Co.
Riehle Testing Machines Division, American Machine & Metals
Rubicon Co.
Scott Testers, Inc.
Service Diamond Tool Co.
Thwing-Albert Instrument Co.
Wheeler Co., Inc.
Wilson Mechanical Instrument Div., American Chain & Cable Co.



**The Photographic Exhibit engendered much interest at the Annual Meeting. Prize-winning pictures from all classes will be reproduced in future BULLETINS. The complete list of awards will appear in the September issue.**

## *The Exhibit Showed New Trends*

(*Continued from page 11*)

formability of a sheet metal. Despite limitations, however, existing tests and methods of analysis have served as useful guides. In the paper the authors describe a method for obtaining the actual rate of strain hardening (tangent modulus).

R. H. Heyer, supervising metallurgist, Research Lab., Armco Steel Corp., presented quite illuminating comments on the paper. His concluding statement admitted that the present choices of formability criteria are rather speculative and pointed out that the tangent modulus at maximum load now takes its place as one of the newest criteria.

### pH Measurement Symposium

## *Is "pH" a misnomer?*

JUST what is the pH value? What are its restrictions and limitations? What is recommended standard practice? What about measuring pH at high temperatures and pressures, in nonaqueous solutions, in blood—and what is involved in instrumentation for pH measurements? These and other questions were either answered or greatly clarified at the Symposium on pH Measurement.

According to R. G. Bates, of the National Bureau of Standards and chairman of the Symposium Committee, the operational definition of pH—based on the observed difference of electromotive force of the pH cell when the standard reference solution is replaced by the test solution—has extended greatly the application of pH measurements but it has led to confusion in interpretation of these measurements. The term pH is therefore losing its precise meaning and becoming instead a synonym for "acidity." The experimental pH is important primarily because of its reproducibility and it is not to be interpreted generally as indicating a particular "hydrogen ion concentration" or "hydrogen ion activity." Dr. Bates went on to elucidate the basic theory upon which the NBS pH standards are based and to describe their preparation and properties.

John E. Leonard of Beckman Instrument Co. discussed some of the industrial problems in pH measurements with particular emphasis on measurements at high temperatures and pressures such as are encountered in sulfite pulp digesters in the paper industry and in other types of chemical reaction vessels. Mr. Leonard pointed out that while absolute determination of pH is impractical in many cases, if measurements can be made with predictable day-to-day reproducibility and with knowledge of the service life of the electrode system at the conditions encountered, good empirical control can be attained, and theoretical interpretation is of relatively minor importance in these cases. He outlined the present state of the art of high-temperature and high-pressure pH measurements as reported in the literature, and he reported on an experimental investigation on pH measurement under these extreme conditions.

W. R. Clark of Leeds & Northrup, described a number of types of commercial instruments for making pH and related emf measurements. He outlined the design characteristics of four basic types—the simple null-detector, the direct-coupled feedback amplifier, the null recorder, and chopper-type feedback stabilized type of instrument. He discussed the relative advantages of each type of instrument and indicated the versatility of the instruments for making measurements other than pH, such as Karl Fischer titrations, titrations with controlled current input, derivative polarographic titrations, methods based on controlled current scannings, automatic titration using electrically generated titrants, voltammetric measurements at constant current, and even for measurement of conductance by d-c methods rather than by conventional a-c methods.

Seemingly a far cry from engineering materials is the subject discussed by Julius Sendroy, Jr., of the Naval Medical Research Inst.: measuring the pH of blood and other biological fluids. While the medical terminology used may have eluded some of the engineer members of the audience, Dr. Sendroy's exposition served to round out the symposium to provide coverage of all types of pH measurement whether in a high-pressure chemical vessel or in the human body. He outlined the problems involved in very accurate measurements of pH of blood, a fluid which is subject to rapid change unless handled under carefully controlled conditions.

Henry Freiser, of the University of Pittsburgh, covered the various aspects of pH measurements as related to analytical chemistry. Specific reactions covered were the Bronsted-Lewis acid-base reactions, and oxidation-reduction reactions. He outlined the present state of the theory for calculating various physicochemical constants based on these reactions.

The problems and theory of acidity measurements in nonaqueous media were covered by Martin Kilpatrick of Illinois Inst. of Technology, and M. A. Paul of Harpur College (F. A. Long, Cornell University, co-author). Prof. Kilpatrick discussed emf and spectrophotometric methods in elucidating the theory. He pointed out that neither concentration nor activity (of hydrogen ions) is measured on a thermodynamic basis and the lack of clarity in definitions and assumptions in attempting to measure either concentration or activity of hydrogen ions in aqueous solutions has led to a great deal of confusion. In general, Prof. Kilpatrick, brought up to date the state of the theory as presented by him at the 1946 Symposium on pH Measurement (ASTM *STP 73*).

Professor Paul discussed a number of aspects of indicators, both for nonaqueous solvents and for strong and weak acids in aqueous solutions. He pointed out that some organic compounds which show no color change in

### HOSPITALITY
### by the Philadelphia District

TO THE Philadelphia District members, hosts to the 59th Annual Meeting, goes no small share of the credit for the success of this year's gathering. A fine entertainment program for the ladies throughout the week, and for all those attending the annual dinner, floor show, and dance, was provided by the Philadelphia men, long experienced in Annual Meeting hospitality.

District officers who planned the program were Chairman E. K. Spring, Henry Disston & Sons, Inc.; Vice-Chairman Tinius Olsen II, Tinius Olsen Testing Machine Co.; Secretary A. H. Kidder, Philadelphia Electric Co. E. J. Albert, Thwing-Albert Instrument Co., was chairman of the dinner committee and Percival Theel was chairman of ladies' entertainment.

REGISTRATION—ANNUAL MEETINGS.

| | Year | Members | Committee Members | Visitors | Total | Ladies |
|---|---|---|---|---|---|---|
| Detroit | 1948 | 1160 | 358 | 250 | 1768 | 133 |
| Atlantic City | 1949 | 1092 | 530 | 235 | 1857 | 335 |
| Atlantic City | 1950 | 1160 | 637 | 334 | 2131 | 408 |
| Atlantic City | 1951 | 1220 | 660 | 402 | 2282 | 393 |
| New York | 1952 | 1375 | 674 | 557 | 2606 | 280 |
| Atlantic City | 1953 | 1290 | 786 | 394 | 2470 | 445 |
| Chicago | 1954 | 1223 | 700 | 306 | 2224 | 178 |
| Atlantic City | 1955 | 1341 | 862 | 323 | 2537 | 234 |
| Atlantic City | 1956 | 1497 | 887 | 512 | 2896 | 204 |

the visible range can be used as indicators because of changes observable in the ultraviolet and they may conveniently be adapted as indicators by the use of an ultraviolet spectrophotometer.

This symposium, scheduled for publication later this year, will be an important permanent addition to the literature on pH measurement, bringing together as it does a well-rounded exposition of both the theoretical and practical aspects of the present state of knowledge of pH measurement.

**Fatigue Sessions**

## Papers stir up much enthusiastic discussion

A WIDE range of new research data on the subject of fatigue, presented in two sessions at the Annual Meeting, was enthusiastically received by the large audiences. Eight papers were presented covering statistical analysis of fatigue data, bending fatigue strength, and fatigue properties of cast steel, wrought alloys, and titanium alloys. Abstracts of most of these papers appeared in the April issue of the BULLETIN.

M. N. Torey and G. R. Gohn, of the Bell Telephone Laboratories, presented a paper on "A Study of Statistical Treatment of Fatigue Data," which excited considerable comment. In this paper the authors summarized results of reversed-bending fatigue tests on two lots of phosphor bronze strip. The authors made a preliminary analysis of observations on more than 1000 specimens tested in groups of 48 at 9 to 12 different deflection levels and presented the original test data so that others interested in the statistical aspects of fatigue may work with these data.

In commenting on this paper, F. B. Stulen and H. N. Cummings, of the Curtiss-Wright Propellor Division, expressed a great deal of satisfaction because the findings and conclusions of the author confirm "our own findings and conclusions." F. A. McClintock, of Massachusetts Institute of Technology, "suggested that the usefulness of these interesting results would be increased by the presentation of data on the reproducibility of the machining and on the variability of the strip stock from side to side and from one length to another.

H. E. Frankel and J. Lieblein, of the National Bureau of Standards, commented on the value of this extensive data but suggested that several points might be clarified. They questioned the introduction of log-log normal distribution in an attempt to fit the data. Further discussion by E. H. Schuette, of the Dow Chemical Co., and J. C. Mülson, of the Aluminum Laboratories Ltd., pointed out the importance of these test data to others who wish to make use of the experimental results for their own statistical treatment.

A. A. Blatherwick and B. J. Lazan, University of Minnesota, presented a study of the relationships of stress redistribution during fatigue loading to the shape effects. They also examined the influence of type of test on fatigue strength.

In his discussion of this paper, G. R. Gohn reported results of two series of tests that likewise demonstrate that changing cyclic properties do alter the stress distribution during fatigue tests. Gohn took issue with the authors for their use of the terms "strain hardening" and "strain softening."

M. S. Hunter and W. S. Fricke, Jr., of the Aluminum Company of America, reported their observations of fatigue cracks in aluminum alloys from their inception to complete failure of the specimen and explain the manner in which fatigue cracks form, propagate, and interact.

John A. Bennett, of the National Bureau of Standards, questioned some of the details regarding branching and discontinuous propagation of the fatigue cracks. On the same paper F. A. McClintock, asked for a description of the authors' chemical polishing and replica techniques in more detail.

A new wire fatigue machine was described by H. T. Corten and G. M. Sinclair of the University of Illinois. The machine, which operates on the principle of a deflected rotating strut, was designed especially for an investigation of the influence of complex stress histories on fatigue life. The major difference between this and previous wire machines is that the stress may be changed rapidly from one level to another without inducing extraneous vibration in the specimen.

The enthusiasm accorded these two sessions was evidence of the great interest in new developments in the field of fatigue.

## Annual Meeting Papers Available

SOME of the papers not preprinted for the 1956 Annual Meeting were mimeographed primarily for the use of those interested in presenting discussion. A limited number of these are available from ASTM Headquarters, 1916 Race St., at a nominal charge.

*The Role of Specific Gravity in the Design and Control of Bituminous Paving Mixtures* by C. A. Carpenter

*Impact Properties of Quenched-and-Tempered Alloy Steels* by J. P. Sheehan and Harry Schwartzbart

*A Tensile Study of Brittle Behavior of a Rimmed Steel in the Temperature Range of −269 to 160 C* by E. T. Wessel

*Effect of Revibration on Properties of Portland Cement Concrete* by D. H. Sawyer and S. F. Lee

*Automatic Equipment and Comparative Test Results for the Four ASTM Freezing-and-Thawing Methods for Concrete* by H. T. Arni, B. E. Foster, and R. A. Clevenger

*Use of Fly Ash in Concrete* by A. G. Timms and W. E. Grieb

*Studies Relating to the Testing of Fly Ash for Use in Concrete* by R. H. Brink and W. J. Halstead

*Ion-Exchange in Analytical Chemistry* by Robert Kunin

*The Use of Ion-Exchange Techniques in Analytical Chemistry and Radiochemistry* by J. E. Hudgens

*Performance Studies of Reference Electrodes and Their Components at High Temperatures and Pressures* by John E. Leonard

*Modern Developments in pH Instrumentation* by W. R. Clark and G. A. Perley

*Theoretical and Practical Problems in the Measurement of Acidity in Nonaqueous Media* by Martin Kilpatrick

*Present Practices in Tensile-Strength Testing of Paper in Industry* by John Fachet and F. T. P. Plimpton, Jr.

*Tension-Testing of Plastics* by F. W. Reinhart

*Tension-Test Methods for Wood, Wood-Base Materials and Sandwich Construction* by L. J. Markwardt and W. G. Youngquist

*Fatigue Crack Propagation in Aluminum Alloys* by M. S. Hunter and W. G. Fricke, Jr.

*Fretting Wear of Zircaloy-2 Pellets in High-Temperature Water* by L. A. Waldman and P. Cohen

*The Mechanical Properties of Type 201 Chromium-Nickel Manganese Stainless Steel Sheet* by R. A. Walsh, R. L. Cook, and R. A. Lula

*The New AISI Types 201 (17-4-6) and 202 (18-5-8) Production and Fabrication* by G. W. Hinkle

*Measurement and Purification of Steam to 0.01 ppm Total Dissolved Solids* by W. B. Gurney

*Field and Laboratory Determinations of the Bearing Capacity of Hard Pan for Design of Deep Foundations* by W. S. Housel

*Stress-Strain Relations in Plastic and Frictional Soils* by D. C. Drucker

*The Impact-Absorbing Capacity of Textile Yarns* by J. C. Smith, F. L. McCrackin, and H. F. Schiefer

# NEW OFFICERS

President

Vice-President

**Rudolph A. Schatzel** has been vice-president and director of engineering of Rome Cable Corp. since 1945.

Born in Kingston, N. Y., Mr. Schatzel received his B.S. in Chemistry from Union College in 1921 and his M.S. in 1923. On June 10, 1956, Union College conferred the honorary degree of Doctor of Science. Associated with the wire industry since 1924, Mr. Schatzel has distinguished himself in research and development work on electrical cable insulations, particularly rubber and plastics.

In ASTM Mr. Schatzel has been particularly active in Committee D-11 on Rubber and Rubber-Like Materials, for many years Chairman of Subcommittee V on Insulated Wire and Cable, and Committee B-1 on Wires for Electrical Conductors.

During World War II he was very active in the War Production Board; was chairman of the Industry Consulting Committee for Rubber Insulation. He served as chairman, Wire and Cable Industry Advisory Committee for Navy Shipboard Cables, and in 1945 was made a member of the U. S. Technical Intelligence Committee which investigated German research in synthetic rubber.

Mr. Schatzel has written many technical papers, and holds many patents. His memberships include the American Chemical Society, American Inst. of Chemists (Fellow), American Inst. of Electrical Engineers, American Society for Metals, American Assn. for the Advancement of Science, American Inst. of Mining and Metallurgical Engineers, Society of Naval Engineers, Editorial Advisory Board of *India Rubber*. He is also president of the Board of Trustees of the Central New York School for the Deaf and president of the Rome Board of Education.

**Kenneth B. Woods** has held the dual position of head, School of Engineering, and director, Joint Highway Research Project, at Purdue University since 1954.

Born in Sunnyside, Wash., Professor Woods received his B.S. degree in Civil Engineering from the Ohio State University in 1932, receiving his professional degree in Civil Engineering in 1937. He is a registered professional engineer in Indiana.

In addition to his academic duties, Prof. Woods has been engaged in large-scale engineering work and engineering research for both Canadian and U. S. Government agencies as well as for railroad and other industrial concerns.

In January 1956 he was elected chairman, Highway Research Board, National Research Council, and was presented the 1945 Highway Research Board Award for a paper of outstanding merit on highway materials. In 1949 he received the Distinguished Service Award of the Highway Research Board.

He has a long record of active service in ASTM. He is Chairman of Committee D-4 on Road and Paving Materials; a member of Committee D-18 on Soils for Engineering Purposes; member of C-9 on Concrete and Concrete Aggregates (Chairman from 1946 to 1952); and served on the Administrative Committee on Papers and Publications for several years. He has served as Director of the Society since 1953.

Memberships in other societies include American Society of Civil Engineers, the Assn. of Asphalt Paving Technologists, American Road Builders' Assn., American Concrete Inst., The Society of American Military Engineers, The American Society for Engineering Education.

Director

**Miles N. Clair,** president of Thompson and Lichtner Co. of Brookline, Mass., was born in Lickdale, Pa. He received his B.S. in Engineering from Drexel Institute of Technology in 1921 and his M.S. in C.E. from Massachusetts Institute of Technology in 1923. Mr. Clair taught at M.I.T. for a short time before joining the Thompson & Lichtner Co. as engineer in charge of testing and inspection. He became vice-president in charge of engineering in 1928 and in 1930, first vice-president and treasurer. He was elected president of the company in 1950.

Mr. Clair first became associated with ASTM as representative of the Thompson & Lichtner Co. on Committee C-1 on Cement and Committee C-9 on Concrete and Concrete Aggregates. He also represents the company on Committee D-18 on Soils for Engineering Purposes and represents the American Concrete Inst. on ASA Sectional Committee A 1. Mr. Clair represents ASTM on the ASA Construction Standards Board and is a member of the New England District Committee. He has served on the Administrative Committee on District Activities since 1949.

Mr. Clair has been instrumental in the development of lightweight concrete roof slabs and the use of concrete made with fine and coarse cinders for structural purposes.

He also holds membership in the American Concrete Inst., The Boston Society of Civil Engineers, and the American Society of Civil Engineers.

Director

**Howard C. Cross,** asssitant technical coordination director of Battelle Memorial Institute, is a native of Washington, D. C., and received his B.S. in chemical engineering, in 1927, from George Washington University.

His professional career as a metallurgist began earlier when in 1921 he was employed by the National Bureau of Standards. Mr. Cross remained with the Bureau until 1929 when he went with Battelle Memorial Inst. as a research engineer. He became chief of his division at Battelle in 1942.

A member of ASTM since 1931, Mr. Cross has been closely associated with research on metals for service at elevated temperatures for more than 30 years. At present he is secretary of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals.

He served as chairman of the Columbus Chapter of the American Society for Metals in 1948. He was a member of a committee which compiled heat-resistant alloys sections of the 1948 edition of the ASM Metals Handbook.

As a special committee chairman engaged in organizing the heat-resistant alloys section of the 1954 Metals Handbook supplement, Mr. Cross has contributed time and effort in his specialized field of heat-resistant metals and alloys.

Director

**George H. Harnden,** consultant in materials and processes, Engineering Standards Service, of General Electric Co., was born in Mexico, N. Y., and was graduated from Clarkson College of Technology with a B.S. degree in mechanical engineering in 1924.

He entered the employ of the General Electrical Co. at Schenectady that summer as test engineer and in 1928 transferred to the Materials Testing Laboratory. He became interested in engineering standards work in 1930 through the development of material specifications and associated engineering data.

In ASTM Mr. Harnden has served on Technical Committees B-1 on Wires for Electrical Conductors; B-5 on Copper and Copper Alloys, Cast and Wrought; and D-2 on Petroleum Products and Lubricants and D-13 on Textile Materials. Mr. Harnden is also a charter member of Committee D-6 on Paper and Paper Products and served as its secretary for eight years. He was a charter member of Committee E-11 on Quality Control of Materials; and in addition he has been active on A-1 on Steel; B-2 on Non-Ferrous Metals and Alloys; B-7 on Light Metals and Alloys, Cast and Wrought; B-8 on Electrodeposited Metallic Coatings; and E-1 on Methods of Testing. He became an individual member of the Society in 1946 and has served on the Administrative Committee on Standards since that time. He received the ASTM Award of Merit in 1952. Since June 1954 he has represented the General Electric Co. under its Sustaining Membership. Mr. Harnden is also active in the work of the American Standards Assn., and the National Electrical Manufacturers Assn.

Director

**R. R. Litehiser,** engineer of tests, at Ohio State Highway Testing Laboratory, Ohio State University, is a native of Eaton, Ohio, and a 1921 graduate of Massachusetts Institute of Technology following a period of service in World War I.

Upon graduation, he worked for two years with the Ohio Department of Highways and then began work with the Railways Bureau of the Portland Cement Assn. in Chicago, and in 1926 became Office Engineer of the Association's office at Columbus, Ohio. He became Engineer of Tests for the Ohio Department of Highways in 1930 and has served continuously except for one year when he was engineering director for the New York State Crushed Stone Assn. in 1938, and served with the Army in World War II, 1941–1946.

He became a member of ASTM in 1930 and has held membership on various committees and subcommittees dealing with highway construction materials. He is presently chairman of Committees C-1 on Cement and C-13 on Concrete Pipe. He is also chairman of the Department of Materials and Construction of the Highway Research Board and is a member of the Committee on Materials, American Assn. of State Highway Officials.

His other society memberships include the American Society of Civil Engineers and the National Society of Professional Engineers.

Director

**Charles R. Stock,** senior group leader, Physical Measurements Laboratories of American Cyanamid's Stamford Laboratories, joined that organization in 1937, became group leader for physical measurements of plastics in 1942 and assumed his present position in 1945. He has taken part in the company's development of urea, melamine, polyester, and polymethylstyrene plastics and its acrylic fibers.

Mr. Stock was born in New York City and attended Columbia University. He has been primarily in applied physical and physicochemical research, including acoustics with Bell Telephone Laboratories and engineering development of tools and silver alloys with S. S. White Manufacturing Co.

Mr. Stock has been associated with ASTM since 1938, when he became a member of Committees D-20 on Plastics, D-9 on Electrical Insulating Materials, and later Committee D-13 on Textiles. He has acted as chairman of a number of sections and subscommittees, and has served as an ASTM representative on the American War Standards Committee of the American Standards Assn., the Armed Services Special Research Advisory Committee on Plastics and on Technical Committee 61 (Plastics) of the International Standards Organization.

Mr. Stock is a former chairman of the Plastics Technical Committee of the Manufacturing Chemists Assn. and has served for a number of years on the Technical Committee of the Society of the Plastics Industry. He is a member of the Society of Rheology and The Fiber Society.

Ion-Exchange Symposium

## Techniques applicable to chemical analysis

AN ATTENDANCE of 150 evidenced the interest in the symposium on ion-exchange and chromatography in analytical chemistry. While the symposium was intended to apply particularly to the analysis of metals, three of the four papers (by Robert Kunin, J. E. Hudgens, and Kurt Kraus) presented a coverage of ion-exchange and associated chromatographic techniques applicable to chemical analysis in general. The fourth paper (by J. L. Hague) covered the application of ion-exchange techniques specifically to the analysis of metals.

One of the valuable applications of ion-exchange techniques is in the concentration of extremely dilute solutions of electrolytes, thus making possible analysis for trace constituents where the concentration is below the sensitivity of the available test method.

Also the fractionation of ions not readily separated by conventional techniques is made possible by ion exchange. Such ions include rare earths, alkaline earths, alkali metals, platinum group metals, halides, etc. Certain other closely related ions, such as cobalt and nickel, can be readily and quantitatively separated.

A virture of the ion-exchange technique is speed and simplicity in most cases.

The papers also included considerable discussion of the various types of ion-exchange resins and the basic principles of ion-exchange – chromatographic techniques.

Tension Testing Symposium

## Nonmetallic materials present wide range of problems

THE TENSION testing of metallic materials is viewed by many as being reasonably well standardized since the range of properties to be determined is relatively narrow. This is certainly true in comparison to the range of properties to be expected with the various nonmetallic materials with rubber and textiles at one extreme and wood at the other. The testing of the various nonmetallic materials presents most interesting problems both with respect to the gripping of specimens and the application of load. Each one of the presentations was fascinating in its own way.

Much of the credit for the success of the session is due to the Chairman, A. C. Webber, E. I. du Pont de Nemours & Co., Inc., who had organized the symposium and at the conclusion of the presentations made an admirable summary of the various points brought out.

Soils

## Symposium on vane method of soil testing, a device for in-place shear tests

A NUMBER of individuals in this country have been making use of a shear testing device for making in-place shear tests of foundation soil. The so-called vane method was developed in the Scandinavian countries and some of the apparatus used in this country has been imported from these countries. Other experimenters have devised their own equipment. The symposium comprised a description of the various procedures in use and an exchange of experiments on the part of those who have been experimenting with this procedure. The introduction by the Chairman, J. O. Osterberg of Northwestern University, was an excellent outline of the various considerations involved, which was ably supplemented and amplified by the several individual papers.

The symposium provided an opportunity for many of those in the audience to raise questions concerning the operation of the test equipment and to indicate in what respects further work will need to be conducted in order to develop procedures that will give comparable results.

It is hoped to make the papers and discussions available at a fairly early date in view of the interest expressed.

**Honorary Member and Past-President G. H. Clamer hasn't missed an Annual Meeting in 53 years.**

## Report on a 30-year study of bearing capacity of hardpan

THE Session on Soils covered a wide range of topics of considerable importance in soils engineering.

A thirty-year program of soil investigations involving both field and laboratory tests on the bearing capacity of hardpan for deep foundations, undertaken by the University of Michigan in cooperation with other organizations, was summarized by W. S. Housel, University of Michigan. Justice could not be done to this very comprehensive and worth-while review in the short time allowed Professor Housel for the presentation. By the use of slides, however, data and graphs were shown illustrating the successful use of the penetration method for measuring soil resistance; relationships between the ring shear, unconfined compression, and triaxial compression tests; and the correlation of these laboratory tests with field penetration.

R. K. Bernhard, Rutgers University, presented a paper jointly prepared with M. Chasek and P. Griggs, describing their experiments with gamma-ray transmission through soils. The paper was well illustrated to show many of the unusual problems encountered in this type of study, problems which because of the danger of exposure to radiation, are not ordinarily encountered. The possibilities of improving soils study techniques by this method are promising.

The evaluation of lime for stabilization of loess was discussed by J. G. Laguros, from a paper prepared by D. T. Davidson and R. L. Handy, Iowa State University, and T. Y. Chu of New York University. Laboratory results of tests by the authors have pointed out the desirability of evaluating a lime separately, prior to its use for stabilization, thus aiding in the selection of the proper lime and predicting its most desirable properties.

Many of the pitfalls of attempting to design on the basis of laboratory tests which have been made on soils samples without giving consideration to the environment of the soil and place were discussed by D. M. Burmister of Columbia University.

N. W. McLeod, Department of Transport, Ottawa, Canada, presented an illustrated discussion describing some simple but ingenious charts which have been developed for determining the relationship between moisture content, density, and void properties of soils.

Bituminous Coated Aggregates

## Quick and accurate determinations of specific gravity in compacted mixtures

SPECIFIC gravity is customarily used in determining compaction of the bituminous mixtures. In the past it has been the practice to measure individually the specific gravity of each component in order to determine the correct mixture proportions. This has not been an accurate or satisfactory procedure. The five papers presented in this symposium discussed various procedures whereby the specific gravity of the bituminous mixture may be measured quickly and accurately using small portions of the compacted mixture. The authors discussed the pitfalls involved in the choice of bulk and apparent and true specific gravity as a means of determining the proper ratio of bitumen to aggregate. Since water is absorbed by aggregates in a greater proportion than bitumen, a value termed effective specific gravity was discussed as being applied to bitumen absorption.

Williams, Grimmer, McAdams, and Yanoshek, of Ohio State University, used air-pressure changes as a means of measuring core and loose bituminous-coated aggregate volumes. Serafin, Michigan State Highway Dept., introduced solvents to dissolve the asphalt thus releasing the air trapped in aggregate voids prior to determining specific gravity. Martin and Layman, Asphaltic Concrete Assn. of Oklahoma, obtained specific gravity by overfilling the mixture with asphalt and then calculating the effective specific gravity from an equation.

Rice, National Crushed Stone Assn., utilized a vacuum procedure which removed entrapped air from the uncompacted mixture sample and then placed the sample in water to determine the maximum specific gravity. McRae, Corps of Engineers, presented a discussion of a new approach based upon a mechanically driven kneading compactor. This apparatus for compaction may possibly eliminate the need for determining the specific gravity of aggregate.

Much comment and discussion was made on the papers in the general tenor that the methods presented were significant contributions to this study.

### 50-YEAR MEMBERS

Charles E. Fuller
Earl B. Smith
American Bureau of Shipping
American Steel Foundries
The Anaconda Co.
Cornell University Library
The Iron Age
University of Kansas Library
University of Melbourne Library
Norfolk & Western Railway Co.
Pittsburgh Plate Glass Co., Paint Division
Southern Pacific Co.
United States Testing Co., Inc.

### 40-YEAR MEMBERS

American Chain and Cable Co., Inc.
American Concrete Pipe Assn.
The American Institute of Architects, Cincinnati Chapter
American Manganese Bronze Co.
The American Metal Co., Ltd.
American Pipe and Construction Co.
Arthur O. Austin
Boston & Maine Railroad
Sumner E. Campbell
Canadian General Electric Co., Ltd.
The Consolidated Mining and Smelting Co. of Canada, Ltd.
Continental Foundry and Machine Co.
The Detroit Edison Co.
Duquesne Slag Products Co.
Lewis A. Eisenhard
The Firestone Tire and Rubber Co.
Arthur Percy Morris Fleming
Roy M. Green
Herman A. Holz
Hudson Wire Co.
International Smelting and Refining Co., Raritan Copper Works
Frank H. Jackson
The Kerite Co.
Lloyd McEntire
Narragansett Electric Co.
The Ohio Brass Co., Barberton Division
Ontario Department of Highways
Pennsylvania Forge Corp.
City of Philadelphia, Department of Wharves, Docks and Ferries
Portland Cement Association
City of Portland, Department of Public Works
John McE. Sanderson
Socony Mobil Oil Co., Inc.
Jerome Strauss
Texas Agricultural and Mechanical College, Civil Engineering Department
United States Steel Supply Div., United States Steel Corp.
Wylie B. Wendt

Concrete

## Use and testing of fly ash

TWO PAPERS on fly ash presented in this session, are welcome additions to the growing bibliography of papers providing pertinent information on the properties and experience with its use in concrete. The paper by A. G. Timms and W. E. Grieb, Bureau of Public Roads, entitled "Use of Fly Ash in Concrete," presented very interesting data and conclusions on the properties of concrete containing as replacement for part of the cement, four fly ashes from two widely separated areas. The effect on strength, volume change, and durability was studied. Although early strengths of concretes containing fly ash were in each case lower than the comparable concrete without fly ash, in no case did the concrete with fly-ash substitutions fail to exceed the flexural strength of the concrete without fly ash at the 1-yr period. The use of fly ash in concrete subject to the application of calcium chloride for ice removal is questionable with respect to increasing the resistance of the concrete.

A second paper entitled, "Studies Relating to the Testing of Fly Ash for Use in Concrete," by R. H. Brink and W. J. Halstead, Bureau of Public Roads, discussed the effect of fly ash on the strength of portland-cement–fly ash mortars as being indicative of the probable effect on the strength of concrete. The results of the tests indicated that generally the strength developed in portland-cement–fly ash mortars is related to the carbon content of the fly ash, the fineness of fly ash, and the water required for mortars. Although the data presented indicated that fly ashes of a selected quality, as measured by the strength index, will generally meet the limits for carbon content, loss of ignition, fineness, and water requirement ratio, it was pointed out that limits on these properties alone would not always insure a particular level of pozzolanic activity.

An interesting subject was discussed in a paper on the effect of revibration on the properties of portland-cement concrete by D. H. Sawyer and S. F. Lee, Kentucky Department of Highways. It has been the traditional opinion and concept for years that "green" concrete should not be disturbed. The authors concluded that revibration will increase the strength of concrete after any period of delay as long as the mix can be brought to a plastic state, even if the

vibrator must be forced into the concrete. The durability of nonair-entrained concrete is critically decreased, while the durability of air-entrained concrete is not significantly affected by revibration.

A statistical study of flexural strength of concrete beams was presented by L. A. Palmer for William C. Otto, both of the Bureau of Yards and Docks. The problem of obtaining concrete air-field pavements of uniformly good flexural strength is greatly facilitated by establishing control limits.

A good contribution toward the analysis and comparison of the four ASTM methods of test for resistance of concrete specimens to freezing and thawing is made in the paper by H. T. Arni, B. E. Foster, and R. A. Clevenger, National Bureau of Standards, entitled "A Comparison of the Durability of Six Concretes as Measured by the Four ASTM Freezing-and-Thawing Methods." A description of the automatic apparatus used to operate all four methods simultaneously and details of the development and operation were presented, aided by the use of excellent colored slides. One general conclusion of the tests was that significant discrimination between aggregates was obtained only in the slow freezing-in-air and thawing-in-water method.

In the paper "Correlation of Sonic Properties of Concrete with Creep and Relaxation" by T. S. Chang and C. E. Kesler, University of Illinois, the theory of rheological models was used as the means of obtaining a possible correlation. The results of this study indicated a relationship between the static and dynamic behavior of concrete and that this relationship may be represented by a nonlinear rheological model.

### Steam Quality Symposium

## *Techniques of measurement and corrections*

THE Symposium on Steam Quality presented a comprehensive coverage of the various techniques for measuring steam quality, and also of the corrections to be applied to such measurements.

W. B. Gurney, Gulf States Utilities Co., described a procedure based on occluding the solids in the steam by moisture produced by a pressure drop in steam passed through a suitable separator, and determination of the solids content by conductivity measurements or other suitable means.

E. E. Coulter and T. M. Campbell, The Babcock & Wilcox Co., covered steam purity determinations by tracer techniques. It was pointed out that measurement of mechanical carryover by the use of radioactive tracers is extremely sensitive and free of errors due to contamination; therefore this technique is suitable as a basis of comparison for other methods. However, because of cost, the use of the method for testing full-size boilers is impractical.

R. O. Parker and R. J. Ziobro, Griscom Russel Co., discussed the nature and validity of corrections to steam conductivity measurements. It was contended that higher corrections should be made for temperature effect on conductivity measurements than are currently being used, and that degassing should be verified (not assumed) in conductivity measurements.

A. B. Sisson, F. W. Straub, and R. W. Lane covered the principles of operation and details of construction of Larson-Lane steam purity analyzers.

**Honorary Member H. J. Gilkey photographed at the Annual Meeting with Mrs. Gilkey who is the daughter of Dr. A. N. Talbot, an ASTM Past President and first Marburg Lecturer.**

## *First Citations for Quality of Presentations*

APART from maintaining the technical quality of all the papers presented at meetings of the Society, the Committee on Papers and Publications is also interested in having these papers well presented. Much emphasis is being placed currently on the importance of communication. This is found to be particularly significant in conveying ideas or concepts for dealing in technical developments.

With this in mind and also with the view of improving the interest at technical sessions the plan was instituted of grading the character of presentation on the part of the authors. Reporters were assigned to the task of reporting in detail on the character of presentation of all of the papers at the 1955 Annual Meeting. Based upon these reports the three outstanding presentations are selected and recognition is being accorded these three individuals. The presentations in question were the following:

E. A. Anderson on "The Atmospheric Corrosion of Rolled Zinc,"

R. U. Blaser on "Special Corrosion Study of Carbon and Low-Alloy Steels,"

D. M. Teague on "Electron Microstructures of Bainite and Tempered Martensite in Steel."

The Board has taken cognizance of these selections and takes pleasure in citing each of the individuals in question.

**E. A. Anderson** **D. M. Teague** **R. U. Blaser**

# Society Honors Its President and Outstanding Members

THE LUNCHEON held each year at the Annual Meeting honoring the retiring president is always a warm and human event. This year it was a particularly pleasant gathering attended by 368 members and visitors. Past-President Norman L. Mochel presided in his usual capable manner.

In his address, The Challenge of Nuclear Energy Accepted by the Electric Power Industry and ASTM, President Fellows described the status of the effort begun in 1950 by the Dow Chemical Co. and the Detroit Edison Co. to examine the possibility of the development of an economically competitive nuclear-energy heat source for the generation of electric power. He told how this project of industry has grown into a nonprofit corporation of 33 electric power companies and 12 engineering and manufacturing firms with a primary objective of the development of the heat of nuclear fission into a commercially practicable means of electric power generation. The group is known as the Atomic Power Development Assn (APDA). He also described how the Power Reactor Development Co. (PRDC), comprising 18 electric power companies and 8 engineering and manufacturing companies, was organized to build, own, and operate the reactor designed by APDA. Mr. Fellows' complete address will be found on page 71 of this BULLETIN. The inspirational quotation with which he concluded is worth repeating.

> Man is not master of the universe because he can split the atom. He has split the atom because he believed in his own unique mastery. Faith led to the material achievement, not the achievement to faith.

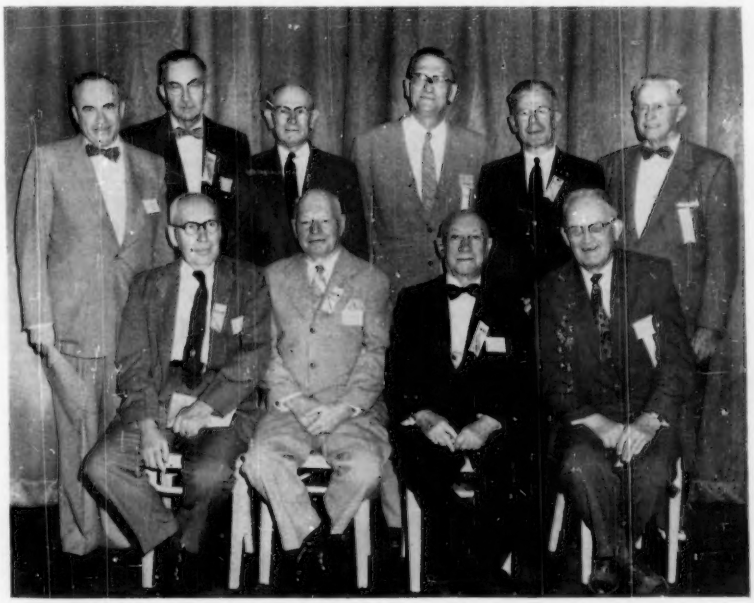
The luncheon also furnished an opportunity for the new officers and directors of the Society to be introduced and for the retiring officers to be recognized. In introducing the new president, who is vice-president of Rome Cable Corp., Mr. Mochel, on behalf of the group, extended to President-elect Schatzel congratulations for his recent recognition by Union College when he received the degree Doctor of Science.

Executive Secretary Painter briefly summarized and discussed the highlights of the report of the Board of Directors to the Society on the completion of a remarkably successful year in membership growth and expansion into new fields of standardization and research. Following introductions by Mr. Mochel, incoming President Schatzel and incoming Vice-President K. B. Woods acknowledged their election with brief statements pledging their continuing efforts to further the work of the Society. The five new directors were also introduced: M. N. Clair, H. C. Cross, G. H. Harnden, R. R. Litehiser, and C. R. Stock. (For pictures and biographies of the new officers, see page 16.) Election tellers were L. Drew Betz and Laurence P. Mains.

Honors conferred by the President on behalf of the Board of Directors included Honorary Memberships to H. J. Gilkey, James T. MacKenzie, H. B. Oatley, and Albert E. White. Awards of Merit were bestowed on eleven men who were presented to President Fellows by George L. Werley, chairman of the Award of Merit Committee. For more about Honorary Membership and Award of Merit recipients, see page 22.

Recognition was also given at the luncheon to those individuals and companies who have held continuous membership in the Society for 40 and 50 years. A complete list of these names appears on page 19.

Junior Vice-President K. B. Woods Speaking at President's Luncheon.



Ten of the Past-Presidents who were at the Annual Meeting. Seated, left to right: T. S. Fuller, J. G. Morrow, G. H. Clamer, C. H. Fellows. Standing: L. C. Beard, Jr., K. G. Mackenzie, T. A. Boyd, H. L. Maxwell, N. L. Mochel, and H. H. Morgan.

# HONORARY MEMBERSHIPS

## *The Society's Highest Honor*

### *Albert E. White*

A. E. White

Albert Easton White, consulting metallurgical engineer; retired director, Engineering Research Inst., and professor of metallurgical engineering, University of Michigan, Ann Arbor, was born in Plainville, Mass., and was graduated from Brown University in 1907.

Following a year of study at Harvard, he was for three years in charge of research on blast-furnace products, ores, etc., for Jones & Laughlin Steel Co. In 1911 he became instructor at the University of Michigan; he was assistant professor 1913 to 1917 and director of engineering research and full professor from 1919 until his retirement in 1953.

A leader in the field of metallurgical research, specifically metallurgy of metals for high-temperature service, Dr. White is the author of more than 100 papers on research and metallurgical subjects. He was awarded the honorary degree of doctor of science by Brown University in 1925.

Dr. White became a member of ASTM in 1914, served on the Board of Directors 1933 to 1935, was Vice-President of the Society 1935 to 1937, and President 1937 to 1938. He has been a member of the Detroit District Council for many years and was elected an honorary member of that group in 1953.

His valued service to ASTM Committee A-1 on Steel began in 1921. For many years he served as Chairman of the A-1 Subcommittee XXII on Valves, Fittings, Pipings and Flanges for High-Temperature and Subatmospheric Temperatures. Committee A-1 elected him to committee honorary membership in 1953. He has also had long periods of service on other technical committees, including A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys; B-2 on Non-Ferrous Metals and Alloys; B-5 on Copper and Copper Alloys, Cast and Wrought; Joint Committee on Effect of Temperature on the Properties of Metals; the Joint Committee on Boiler Feedwater Studies; and also the former ASTM Committee A-4 on Heat Treatment of Iron and Steel, heading the Subcommittee on Castings.

Dr. White's other organizational affiliations include American Chemical Society, American Society for Metals (first president), American Inst. of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and National Research Council Division of Engineering and Industrial Research.

H. J. Gilkey

### *H. J. Gilkey*

Herbert James Gilkey, head of the Department of Theoretical and Applied Mechanics, Iowa State College, Ames, Iowa, is a native of Montesano, Wash. He was graduated from Oregon Agricultural College in 1911 with a B.S. in civil engineering, receiving the same degree from Massachusetts Inst. of Technology in 1916 and in the same year from Harvard University. He received his M.S. from the University of Illinois in 1923 and an honorary doctor of science degree from Buena Vista College in 1939.

Dr. Gilkey was engaged in his early years as a materials consultant and structural and test engineer in Government and private surveys and projects. During World War I he served as Captain, Corps of Engineers, with the AEF in France; and was with the American Relief Administration, under Herbert Hoover in Paris in 1919. From 1919 to 1921 he was with A. R. Lord, Chicago, as structural engineer, during this period advising informally with Lorado Taft on construction of the Fountain of Time in that city.

From 1921 to 1923 he was on the Experimental and Testing Staffs of the University of Illinois; 1923 to 1931 successively assistant, associate, and professor of civil engineering at the University of Colorado. He has held his present post at Iowa State College since 1931.

Eminent in the field of research in engineering materials, especially concrete, he was a member of committees concerned with problems related to construction of several dams, including Hoover Dam.

Joining ASTM in 1924, Professor Gilkey had long periods of service on Committees C-1 on Cement and C-9 on Concrete and Concrete Aggregates. He served on the former Joint Committee on Concrete and Reinforced Concrete, and since 1929 has been a Special Adviser Member of the Subcommittee on Elastic Strength of Materials of Committee E-1 on Methods of Testing.

He has served on the Society's Ad-

J. T. MacKenzie

H. B. Oatley

ministrative Committee on Papers and Publications and has cooperated closely with numerous editions of the "Selected ASTM Standards for Students in Engineering." Through the years he has introduced the activities of the Society to countless engineering students.

He is the author or co-author of several handbooks and manuals, about 150 papers and discussions dealing with concrete, engineering materials, and testing methods.

He has been active in many other societies including the American Society of Civil Engineers, American Concrete Inst., Western Society of Engineers, Iowa Engineering Society, Society of American Military Engineers, National Research Council, and American Assn. for the Advancement of Science.

## James T. MacKenzie

James Tucker MacKenzie, retired technical director, American Cast Iron Pipe Co., Birmingham, Ala., and now associated with the Southern Research Inst, was born in Brooksville, Fla., and was educated at the University of the South (Sewanee) in Tennessee, receiving the B.S. degree. He received his degrees of civil engineer and M.A. in 1912 and honorary doctor of science in 1930 from the same institution. He was on the research and technical staff of the American Cast Iron Pipe Co. for 44 years until his retirement early this year. He is widely recognized as an authority in the cast iron field, especially the metallurgy of cast iron, centrifugal casting of metals, design of cast iron pipe, and cupola melting.

Dr. MacKenzie has contributed much to ASTM technical work, having been a member of the Society for 38 years, serving twice as Director, 1932 to 1934 and 1944 to 1947. He has been a member of ASTM Committee A-3 on Cast Iron since 1926 and was chairman of the committee from 1944 to 1948. He has written a number of technical papers relating to his field.

Dr. MacKenzie has been very active also in the American Foundrymen's Assn., and is a member of the American Inst. of Mining and Metallurgical Engineers, the Electrochemical Society, Iron and Steel Inst. (British), Institute of British Foundrymen, American Ceramic Society, Society of Automotive Engineers, American Chemical Society, Petroleum Inst., Society of Experimental Stress Analysis, American Water Works Assn., Gas Assn., and American Welding Society.

## H. B. Oatley

Henry Bigelow Oatley, consultant, and retired vice-president of engineering, The Superheater Co., New York City, is a native of Rochester, N. Y., and received his B.S. degree from the University of Vermont in 1900 and in 1951 the doctor of engineering degree, also from the University of Vermont. In 1950 Stevens Institute awarded him the degree, doctor of engineering.

In his early professional career, Dr. Oatley worked in the Engineering Department of the American Locomotive Co. from 1900 to 1910 as testing engineer. From 1910 until his retirement in 1950 he was associated with The Superheater Co. He is well known for his achievements in the field of steam generation and has numerous inventions relating to superheaters and other devices.

He served for 36 years as representative of The Superheater Co's ASTM membership and more recently has held personal membership in the Society. He has been a member of Committee A-1 on Steel since 1916 and has contributed immeasurably to the advancement of the Society's purposes through his work on several of the subcommittees of A-1. He was elected to honorary membership in A-1 in 1950 and was elected chairman of the committee in 1953, serving until he relinquished the post in June of this year. His outstanding service which directly affected much of the Society's metals work involving codes was as chairman of the Boiler Code Committee of The American Society of Mechanical Engineers, a committee on which he served for 23 years.

His other organizational affiliations include the Society of Naval Architects and Marine Engineers, the Engineering Institute of Canada, American Society of Naval Engineering, and the Northeast Coast Inst. of Engineers and Shipbuilders (England).

# AWARDS OF MERIT

L. D. Betz H. A. Bright S. Collier

ELEVEN leaders in the field of engineering materials—men who have rendered outstanding service to the American Society for Testing Materials, particularly in its technical committee work—were honored during the ASTM 59th Annual Meeting in Atlantic City with Awards of Merit.

Under the rules of the Award of Merit each technical committee may suggest one candidate annually and the Award Committee may select nominees from other areas of the Society's work as well. While each of the men listed below was honored for intensive work and contributions in a specific field, each has furthered in numerous ways the general activities of the Society.

To **L. Drew Betz,** managing director, W. H. & L. D. Betz, Philadelphia, Pa., in recognition of valued and constructive contributions in various ASTM areas, notably in the field of industrial water and in District activities, and for sustained support of other Society work.

Mr. Betz has been managing director of the firm of W. H. & L. D. Betz since he and his father organized it in 1925. A native of Philadelphia, Mr. Betz was graduated in chemistry from Drexel Institute of Technology in 1914, after which he took an extra year in organic chemistry. From 1914 to 1917 he was a chemist with the Animal Oil Co., Philadelphia, and from 1917 to 1925 chemist and later vice-president with E. F. Drew & Co., Inc., Philadelphia, New York, and Boston. Mr. Betz has been a member of ASTM since 1937. He has been a member of Committee D-19 on Industrial Water since 1942 and currently represents D-19 on the Standards Methods Committee of the American Public Health Assn. He also represents ASTM on the Federation of Sewage Works Assn. A member of the Philadelphia District Council, he has served as both secretary and vice-chairman and has been chairman of the committee for two of the Society's photographic exhibits.

Mr. Betz is also an active member of The American Society for Mechanical Engineers, American Chemical Society, and American Water Works Assn. He has written several articles and papers on various water conditions, processes, and problems.

To **Harry Aaron Bright,** chief, Analytical Chemistry Section, Division of Chemistry, National Bureau of Standards, Washington, D. C., in recognition of notable service in developing and standardizing methods for the chemical analysis of metals, and for his consistent administrative and technical support of Committee E-3 on Chemical Analysis of Metals where he has been a longtime officer.

Mr. Bright has been in charge of the Section on Analytical Chemistry with responsibility for the National Bureau of Standards' program on standard samples of composition and research on methods of analysis, since 1937.

He received his degree of B.S. from Pennsylvania State University in 1912 and the degree of M.S. from George Washington University in 1927. After a brief period in industrial chemistry he joined the staff of the Chemistry Division of the National Bureau of Standards in 1913 as an analytical chemist in the Materials Testing Laboratory. In 1921 he assumed charge of the ferrous laboratory.

Mr. Bright is joint author of two books, "Chemical Analysis of Iron and Steel" and "Applied Inorganic Analysis," and has also published a number of research contributions on methods of analysis.

He has been a member of ASTM since 1935 and has represented the National Bureau of Standards on Committee A-3 on Cast Iron and Committee A-9 on Ferro-Alloys. He is a charter member of ASTM Committee E-3 on Chemical Analysis of Metals.

Mr. Bright is a member of the American Chemical Society and the Washington Academy of Sciences. In 1954 he was awarded a Department of Commerce Medal for meritorious service.

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To **Simon Collier,** director of quality control, Johns-Manville Corp., New York, in recognition of sustained support of ASTM technical and administrative work particularly in Committee D-11 on Rubber and Rubber-Like Materials where as a longtime member and Chairman since 1944 his knowledge and understanding have been so effective.

Mr. Collier has been director of quality control for Johns-Manville Corp. since 1946. He joined the company in 1923 as chief chemist at its Waukegan, Ill., plant, and in 1936 was made manager of inspection and control.

A native of Salem, Mass., Mr. Collier was graduated from Worcester Polytechnic Inst. with a B.S. degree in chemistry in 1916. Prior to joining Johns-Manville he had been with the National Bureau of Standards in charge of rubber work and before that was associated with the Boston Belting Co. as a chemist.

Mr. Collier has for years been a foremost proponent of the statistical approach to quality control and has long recognized the need for quality consciousness both at the operating level and by top management. Because of this, he has felt that an educational approach is imperative and his activities and efforts among industries and engineering institutes have been directed along these lines.

He has been a member of ASTM since 1926 and has been active on several committees, including D-11 on Rubber and Rubber-Like Materials, of which he is currently Chairman. He is a member of C-19 on Structural Sandwich Constructions and E-8 on Nomenclature and Definitions. He also represents Committee D-11 on E-8. He was a

W. L. Fink H. F. Gonnerman B. W. Gonser

member of the Board of Directors of the Society from 1948 to 1951. Mr. Collier is a member of several other societies, including the Chemists' Club of New York City, the American Institute of Chemists, the American Chemical Society, and the American Society for Quality of which he is a founding member.

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To **William LaVilla Fink,** chief, Physical Metallurgy Division, Aluminum Company of America, Aluminum Research Laboratories, New Kensington, Pa., in recognition of longtime constructive work, especially in the field of metallography, for outstanding service in Committee E-4 on Metallography, and for notable constructions in the area of X-ray diffraction.

Mr. Fink has held his present position since 1943.

Dr. Fink attended the University of Michigan where he was awarded his PhD in chemistry in 1926. From 1921 to 1923 he was a teaching assistant in the Chemistry Department and from then until 1925 he was the Charles A. Coffin Fellow. Since graduation, Dr. Fink has worked in the Research Laboratories of the Aluminum Company of America, first in the Casting Branch in Cleveland and after 1931 in the Wrought Products Branch in New Kensington. He was made assistant chief metallurgist in 1930 and achieved his present position in 1943.

Dr. Fink has been associated with ASTM technical committee work since 1931 when he became a member of Committee E-4 on Metallography. He has served on other committees of the Society, including Committee E-7 on Nondestructive Testing, the Joint Committee on Definitions of Terms Relating to Heat Treatment of Metals, and the Joint Committee on Chemical Analysis of Powder Diffraction Methods. He also was an active member of the X-Ray Diffraction Committee of the National Research Council in the 1930's.

He has written or contributed to 42 scientific papers and 12 patents. Dr. Fink is a recognized authority on the subjects of aluminum alloy phase diagrams, metallurgical changes during heat treatment, corrosion, X-ray technique, and nondestructive testing.

He is also a member of the American Society for the Advancement of Science, American Inst. of Mining and Metallurgical Engineers, American Society for Metals, American Chemical Society, American Ordnance Assn., American Crystallographic Assn., Society for Nondestructive Testing, and the British Institute of Metals.

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To **Harrison Frederick Gonnerman,** consulting engineer and research consultant, Oak Park, Ill., in recognition of outstanding service, especially for standards and research work in Committee C-1 on Cement, and in the field of concrete, and for consistent support of other varied ASTM activities.

Mr. Gonnerman has a long record of professional activity in the field of cement and concrete.

A native of Illinois, Mr. Gonnerman was educated at the University of Illinois where he received his B.S., C.E. in 1908, and M.S. in 1913. He was associated with the University of Illinois and its Engineering Experiment Station from 1908 to 1920 serving as assistant engineer, instructor in theoretical and applied mechanics, research associate, and research assistant professor, successively. Later he became associated with the Structural Materials Research Laboratory, Lewis Institute, and the Research Laboratory of the Portland Cement Assn. as associate engineer. He was manager of the PCA Research Laboratory from 1927 to 1946, director of research 1947 to 1948, and assistant to the vice-president for research and development of the Portland Cement Assn., 1948 to 1952.

He is the author of many papers, discussions, and bulletins on cement, concrete materials, reinforced concrete, and methods of testing.

Mr. Gonnerman joined ASTM in 1914. He has served on Committee C-1 on Cement for 30 years and has served as a member and chairman of various subcommittees, including 20 years of service as chairman of the Subcommittee on Volume Change and Soundness of Portland Cement. He has also served on Committee C-12 on Mortars for Unit Masonry and D-4 on Road and Paving Materials. He was a member of the ASTM Executive Committee from 1936 to 1938 and a member of its successor, the Board of Directors, from 1949 to 1952.

F. Hubbard R. P. Koehring V. T. Malcolm J. W. McBurney H. R. Wolf

Mr. Gonnerman has also been active in work of other societies which has advanced ASTM work. He served on the Board of Direction of the American Concrete Inst. 1943 to 1949, and was president of the ACI in 1946. He was elected to honorary membership in the ACI in 1951 and has the distinction of having received twice the Wason Medal for noteworthy research, in 1929 and 1944. In 1952, he received the Sanford E. Thompson Award of ASTM and in the same year was elected to honorary membership in Committee C-1. Mr. Gonnerman is also a member of the American Association for the Advancement of Science, American Society of Civil Engineers, and the Western Society of Engineers.

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To **Bruce W. Gonser,** assistant director, Battelle Memorial Inst., Columbus, Ohio, in recognition of significant leadership in standardization and research work, especially covering non-ferrous metals and alloys, and for valued support of ASTM research activities.

Mr. Gonser is a nationally known authority on non-ferrous metals and has been identified with non-ferrous metallurgy research for more than 30 years. He has made significant contributions to procedures for the extraction, refining, fabrication, alloying, and utilization of metals. His fields of interest have included the common non-ferrous metals, the refractory metals, the so-called "new" commercial metals, the light metals, and the rare or unusual metals. He is the author of more than 100 research papers and technical articles, and has made numerous talks before technical groups throughout the United States and Europe.

Mr. Gonser was graduated from Purdue University in 1923 with a B.S. in chemical engineering, and five years later he received his professional degree. Following his graduation from Purdue, he served for a year as a research fellow at the University of Utah and while there completed requirements for the M.S. degree. He obtained his doctor of science in non-ferrous metallurgy and metallography from Harvard University.

In 1924 he became associated with the American Smelting and Refining Co. as a metallurgical and chemical engineer. For seven years he was engaged in research, development, and pilot plant operation.

Dr. Gonser has been active in ASTM since 1936 when he represented Battelle on Committee B-6 on Die-Cast Metals and Alloys. He is currently chairman of ASTM Committee B-2 on Non-Ferrous Metals and Alloys and a member of Committees B-6 and B-4 on Metallic Materials for Electrical Heating, Resistance and Electrical Contacts. He is chairman of the ASTM Administrative Committee on Research and represents the Society on the National Research Council Division of Engineering. His membership in other societies includes the American Ordnance Assn., American Association for the Advancement of Science, Institute of Metals, and Sigma Xi.

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To **Fred Hubbard,** consulting engineer, The Standard Slag Co., Youngstown, Ohio, in recognition of distinguished and longtime service to the Society, especially in Committee D-4 on Road and Paving Materials, and for support of other important ASTM work.

Mr. Hubbard has held his position since 1925 and during a greater part of that time has served as director of research for the National Slag Assn. He has been closely connected with the production and use of blast-furnace slags as a commercial aggregate since 1907.

He became a member of ASTM in 1926 and shortly afterward was appointed to membership on Committee C-9 on Concrete and Concrete Aggregates and Committee D-4 on Road and Paving Materials. He has been Vice Chairman of Committee C-9 since 1946 and 2nd Vice Chairman of Committee D-4 since 1944 and has been particularly active in the work of several subcommittees. He has been active in writing specifications for hot-mixed hot-laid asphaltic concrete for base and surface courses and asphaltic mixtures for sheet asphalt pavements. Mr. Hubbard is also the author of several papers, including one in the ASTM Symposium on the Significance of Tests and Properties of Concrete and Concrete Aggregates published November 1955.

In 1954 he represented the National Slag Assn. at an international conference in Belgium and presented a paper on the Production and Utilization of Iron Blast-Furnace Slag in the United States.

His other society memberships include the American Concrete Inst. of which he was a member of the Board of Direction, 1943 to 1944.

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To **Roland P. Koehring,** section engineer for research and development, Moraine Products Division, General Motors Corp., Dayton, Ohio, in recognition of valued service to the Society, particularly leadership and support of standards and research work in Committee B-9 on Metal Powders and Metal Powder Products.

Mr. Koehring was associated with the early development of powder metallurgy when in 1921 the General Motors Research Laboratories began development in this field. The first phase of this development was a bronze self-lubricating bearing and later various iron compositions were developed for sintered metal structural parts such as gears, cams, small pistons, etc. Since in powder metallurgy, density is an important physical property of sintered parts, the need for some sort of specifications soon was apparent. Testing methods for powders and parts made from them also were needed. Mr. Koehring was secretary of the Industry Group Conferences begun in 1935 to work out standard testing methods and specifications for powdered metals.

He has been a member of ASTM Committee B-9 on Metal Powders and Metal Powder Products since it was organized in 1944 and was its first Vice-Chairman. He is Chairman of its Subcommittee III on Metal Powder Products. He was a member of the ASTM Ohio Valley District Council in 1952.

Mr. Koehring is also a member of the American Society for Metals, American Institute of Mining and Metallurgical Engineers, American Chemical Society, Electrochemical Society, and the American Ordnance Assn.

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To **Vincent T. Malcolm,** consultant and advisory engineer, The Chapman Valve Manufacturing Co., Indian Orchard, Mass., in recognition of longtime consistent support of many standardization and research projects, notably in the fields of ferrous and non-ferrous metals and for constructive work on the effects of temperature on metals.

Mr. Malcolm has retired from his operational duties and now acts as consulting and advisory engineer to management. He entered the employ of the company in 1921 and became director of research in 1934.

Mr. Malcolm was graduated from Baltimore Polytechnic Inst., attended the University of Maryland, and was graduated as civil engineer from the University of Wisconsin in 1910. He started his engineering career as a transitman with Norfolk & Southern Railroad Co., and later was assistant to division engineer, Baltimore Sewage Commission. In 1913 he became chief inspector of Bartlett-Hayward Co., later becoming engineer of tests in charge of all laboratories and materials. He is credited with some outstanding developments in metallurgical work and

has had many patents issued to him. Articles and reports of his work have been published in the literature of ASTM, American Society of Mechanical Engineers, AFA, American Society for Metals, and other technical publications.

He has been a member of ASTM since 1921, is presently a member of many ASTM committees and subcommittees, including A-1 on Steel; A-3 on Cast Iron; A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys; B-3 on Corrosion of Non-Ferrous Metals and Alloys; E-7 on Nondestructive Testing; B-5 on Copper and Copper Alloys; Joint Committee on Effect of Temperature on the Properties of Metals; Joint Committee on Filler Metal; and represents the Manufacturers Standardization Society of the Valve and Fittings Industry on ASA Project B-36.

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To **John W. McBurney** (retired) consultant on masonry and masonry materials, National Bureau of Standards, Washington, D. C., in recognition of longtime sustained work in the field of building materials, particularly in Committees C-12 on Mortars for Unit Masonry and C-15 on Manufactured Masonry Units.

Mr. McBurney recently retired after 30 years of service. A native of Sumner, Wash., Dr. McBurney was graduated from Ohio State University in 1913 with a B.A. in chemistry and bacteriology and in 1952 was awarded an honorary degree of doctor of science from Marietta College.

He first joined the Bureau staff in 1926 as research associate for the Common Brick Manufacturers Assn. In 1932 he became research associate for the Asphalt and Mastic Tile Assn., and since 1935 he has worked directly on the Bureau's staff, particularly in the fields of masonry, brick, and plaster. He has been a leading figure in the preparation of specifications and standards for masonry, mortar, brick, and asphalt tile. In addition to holding several patents for testing instruments and methods, Dr. McBurney has published many papers in his field. The Hirschwald-McBurney Coefficient is widely used in Europe for predicting the weather durability of heavy clay products, and his "McBurney Indentation Test" for asphalt tile is in international use.

Dr. McBurney joined ASTM in 1921 and has had long and active membership in many committees including Committees C-12 on Mortars for Unit Masonry, C-15 on Manufactured Masonry Units, C-3 on Chemical-Resistant Mortars; E-5 on Fire Tests on Materials and Construction; F-6 on Methods of Testing Building Constructions; and E-8 on Nomenclature and Definitions.

Dr. McBurney has also been active on other groups, including the secretaryship of ASA Sectional Committee A-41 on Masonry and A-42 on Plaster. In addition to ASTM he is a member of many technical and professional societies.

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To **Harry Roscoe Wolf** (retired) Executive Department, Research Laboratories Division, General Motors Corp.; consultant to Fuels and Lubricants Dept., in recognition of longtime valued service to the Society, especially supporting standardization and research work in Committee D-2 on Petroleum Products and Lubricants, and as Charter Chairman of Committee D-15 on Engine Antifreezes.

Mr. Wolf has been employed by the General Motors Corp since 1912 and has been a member of the Research Department since 1921, serving from 1923 to 1941 as assistant head of the Chemistry Department of the Research Laboratories; 1941 to 1945 as head of the Chemistry Department; and from 1945 to 1954 as assistant to the technical director of the Research Laboratories. Since 1954 he has been consultant to fuels and Lubricants Department of the General Motors Research Laboratories.

Mr. Wolf has been responsible for many developments which ultimately have been beneficial to industry and mankind, especially in the field of engine antifreezes. During his early work he established a relationship between temperature aeration and corrosion tendencies within antifreeze systems. He was instrumental in setting up the General Motors simulated test method which was used as the basis for the present ASTM evaluation work.

Mr. Wolf has been a member of ASTM since 1913. He has represented General Motors on Committee D-15 on Engine Antifreezes since it was established in 1947 and served as Chairman from 1951 until March 1956. He has presented or published many technical papers on problems related to the automotive industry, including antifreezes, brake linings, lubrication, and motor fuels.

He is also a member of the American Chemical Society and the Society of Automotive Engineers.

Due to Mr. Wolf's protracted illness, his Award was presented to him prior to the Annual Meeting.

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## *59th Annual Meeting*

### Max Hecht Award

This award was established in 1954 by Committee D-19 on Industrial Water in honor of its first chairman and is given in recognition of outstanding service to the committee in the advancement of its objective—the study of water as an engineering material.

**Abraham A. Berk,** who was the 1956 recipient, is internationally recognized for his work with W. C. Schroeder on the caustic cracking of boiler steel. Out of this project sponsored by the Joint Feedwater Studies came the embrittlement detector for use on an operating boiler and the application of nitrate to boiler waters as an effective and reliable inhibitor of the corrosion mechanism responsible for caustic cracking.

A. A. Berk

Mr. Berk has devoted 25 years of service in the Bureau of Mines to problems encountered in the industrial use of water and has helped improve the chemical conditioning of water in hundreds of establishments of the United States Government. In 1951 he was named chief of the Industrial Water Branch of the Bureau of Mines. Mr. Berk has contributed greatly toward better methods of measurement for the control of chemical conditions in water and has served on ASTM Committee D-19 on Industrial Water and on the Power Test Codes Committee of ASME. Currently he is chairman of the Subcommittee on Deposits of the Joint Research Committee on Boiler Feedwater Studies.

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# New and Extensively Revised Tentatives and Standards (with Serial Designations)

At the Annual Meeting, the Society accepted 83 new tentative specifications and methods of test, the titles and designations of which are given below.

The Society also accepted revisions of 121 existing tentative specifications and methods of test. Of these, 24 have been extensively revised, the titles of which are given below and marked with a single asterisk.

Revisions for immediate adoptions were approved in 75 standards of which there were 13 extensively revised as indicated below with a double asterisk. There were also 13 standards revised and reverted to tentative status.

Designations of the technical committees responsible for these various tentatives and standards are indicated after the boldface headings.

### Steel (A-1)

*Specifications for:*

Chromium-Silicon Steel Valve Spring Quality Wire (A 402 – 56 T)
Chromium-Silicon Steel Spring Wire (A 401 – 56 T)
High Tensile Strength Carbon-Manganese Steel Plates for Unfired Pressure Vessels (A 397 – 56 T)
Factory-Made Wrought Austenitic Steel Welding Fittings (A 403 – 56 T)
Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts Specially Heat Treated for High Temperature Service (A 404 – 56 T)
Seamless Ferritic Alloy Steel Pipe Specially Heat Treated for High Temperature Service (A 405 – 56 T)

*Recommended Practice for:*

The Selection of Steel Bar Compositions According to Section (A 400 – 56 T)

### Corrosion of Iron and Steel (A-5)

*Specifications for:*

Zinc-Coated Steel Poultry Netting (A 390 – 56 T)

### Wires for Electrical Conductors (B-1)

*Specifications for:*

* Tinned Soft or Annealed Copper Wire for Electrical Purposes (B 33 – 56 T)
* Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes (B 189 – 56 T)

### Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts (B-4)

*Methods of Test for:*

** Flexivity of Thermostat Metals (B 106–56)
** Modulus of Elasticity of Thermostat Metals (Cantilever Beam Method) (B 223 – 56)

### Copper and Copper Alloys, Cast and Wrought (B-5)

*Specification for:*

Copper Drainage Tube (DWV) (B 306 – 56 T)

### Light Metals and Alloys, Cast and Wrought (B-7)

*Specifications for:*

Aluminum-Alloy Drawn Seamless Coiled Tubes for Special Purpose Applications (B 307 – 56 T)
Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded (B 308 – 56 T)

### Metal Powders and Metal Powder Products (B-9)

*Specifications for:*

High Density Iron, Sintered Metal Powder Structural Parts (B 309 – 56T)
Low and Medium Density Iron, Sintered Metal Powder Structural Parts (B 310 – 56 T)

*Methods of Test for:*

Green Strength of Compacted Metal Powder Specimens (B 312 – 56 T)
Density of Cemented Carbides (B 311 – 56 T)

### Lime (C-7)

*Specification for:*

Fly Ash for Use as a Pozzolanic Material with Lime (C 379 – 56 T)

### Refractories (C-8)

*Methods for:*

Chemical Analysis of Refractory Materials (C 18 – 56 T), to be added when adopted to Standard Method C 18 – 52.

### Concrete and Concrete Aggregates (C-9)

*Method of Test for:*

*Organic Impurities in Sands for Concrete (C 40 – 56 T)

### Gypsum (C-11)

*Specifications for:*

Annular Ringed Nails for Gypsum Wallboard (C 380 – 56 T)

### Thermal Insulating Materials (C-16)

*Specifications for:*

Cellular Glass Thermal Insulation for Pipes (C 381 – 56 T)
Mineral Wool Felt Insulation (Industrial Type) for Elevated Temperatures (C 382 – 56 T)

*Method of Test for:*

Wet Adhesion of Thermal Insulating Cements to Metal (C 383 – 56 T)

### Natural Building Stones (C-18)

*Method of Test for:*

*Durability of Slate for Roofing (C 217–56 T)

### Acoustical Materials (C-20)

*Method of Test for:*

Impedance and Absorption of Acoustical Materials by the Tube Method (C 384 – 56 T)

### Ceramic Whiteware and Related Products (C-21)

*Definitions of Terms Relating to:*

Ceramic Whitewares and Related Products (C 242 – 56 T), to be added when adopted to Standard Method C 242 – 56.

### Porcelain Enamel (C-22)

*Method of Test for:*

Thermal Shock Resistance of Porcelain-Enameled Utensils (C 385 – 56 T)

### Paint, Varnish, Lacquer and Related Products (D-1)

*Specifications for:*

Safflower Oil (D 1392 – 56 T)

*Methods of Test for:*

Flash Point of Drying Oils (D 1393 – 56 T)
Chemical Analysis of White Titanium Pigments (D 1394 – 56 T)
Abrasion Resistance of Clear Floor Coatings (D 1395 – 56 T)
Analysis of Polyvinyl Butyral (D 1396 – 56 T)
Unsaponifiable Matter in Alkyd Resins and Resin Solutions (D 1397 – 56 T)
Fatty Acid Content of Alkyd Resins and Resin Solutions (D 1398 – 56 T)
Measurement of Dry Film Thickness of Nonmetallic Coatings of Paint, Varnish, Lacquer, and Related Products Applied on a Nonmagnetic Metal Base (D 1400 – 56 T)
Unsaponifiable Content of Tricresyl Phosphate (D 1399 – 56 T)
*Distillation Range of Lacquer Solvents and Diluents (D 1078 – 56 T)
*Nonvolatile Content of Resin Solutions (D 1259 – 56 T)

*Specifications for:*

*Degummed Soybean Oil (D 124 – 56 T)
*Tricresyl Phosphate (D 363 – 56 T)

*Specifications for:*

**Ethylene Glycol Monobutyl Ether (D 330 – 56)
**Ethylene Glycol Monoethyl Ether (D 331 – 56)
**Acetate Ester of Ethylene Glycol Monoethyl Ether (95 per cent Grade) (D 353 – 56)
**Methyl Ethyl Ketone (D 740 – 56)

### Petroleum Products and Lubricants (D-2)

*Methods of Test for:*

Emulsion Characteristics of Steam-Turbine Oils (D 1401 – 56 T)
Estimation of Heat of Combustion of Liquid Petroleum Products (D 1405 – 56 T)
Effect of Copper on Oxidation Rate of Grease (D 1402 – 56 T)

Cone Penetration of Lubricating Grease Using One-Quarter Scale Cone Equipment (D 1403 – 56 T)
Estimation of Deleterious Particles in Lubricating Grease (D 1404 – 56 T)
Liquid Calibration of Tanks (D 1406 – 56 T)
Calibration of Barge Tanks (D 1407 – 56 T)
Calibrating Stationary Horizontal Tanks (D 1410 – 56 T)
Calibrating Spherical and Spheroidal Tanks (D 1408 – 56 T)
Calibrating Tank Car Tanks (D 1409 – 56 T)
*Water in Petroleum Products and Other Bituminous Materials (D 95 – 56 T)

*Method of Test for:*
**Viscosity by Means of the Saybolt Viscometer (D 88 – 56)
**Flash and Fire Points by Means of Cleveland Open Cup (D 92 – 56)
**Flash Point by Tag Closed Tester (D 56 – 56)

### Road and Paving Materials (D-4) and Soils for Engineering Purposes (D-18)

*Methods of Test for:*
Water-Soluble Chlorides Present as Admixes in Graded Aggregate Road Mixes (D 1411 – 56 T)

### Coal and Coke (D-5)

*Method of Test for:*
Equilibrium Moisture of Coal at 96 to 97 per cent Relative Humidity and 30 C (D 1412 – 56 T)

### Wood (D-7)

*Method of Test for:*
Wood Preservatives by Laboratory Soil-Block Cultures (D 1413 – 56 T)
*Evaluating the Properties of Building Fiberboards (D 1037 – 55 T)

### Electrical Insulating Materials (D-9)

*Methods of Testing:*
*Solid Filling and Treating Compounds Used for Electrical Insulation (D 176 – 56 T)
**Varnished Glass Fabrics and Varnished Glass Fabric Tapes Used for Electrical Insulation (D 902 – 56)

### Rubber and Rubber-Like Materials (D-11)

*Methods of Test for:*
Tension Testing of Rubber O-Rings (D 1414 – 56 T)
International Standard Hardness of Vulcanized Natural and Synthetic Rubbers (D 1415 – 56 T)
Chemical Analyses of Synthetic Elastomers (D 1416 – 56 T)
Synthetic Rubber Latices (SR and BR Types) (D 1417 – 56 T)
*Adhesion of Vulcanized Rubber to Metal (D 429 – 55 T)

*Specifications for:*
**Woven Jacketed Rubber-Lined Fire Hose (D 296 – 56)

*Recommended Practice for:*
Nomenclature for Synthetic Elastomers and Latices (D 1418 – 56 T)
Description of Types of Styrene Rubbers (SR) (D 1419 – 56 T)
Description of Types of Styrene Rubber (SR) and Butadiene Rubber (BR) Latices (D 1420 – 56 T)
Interlaboratory Testing of Rubber and Rubber-like Materials (D 1421 – 56 T)

### Soaps and Other Detergents (D-12)

*Methods for:*
*Sampling and Analysis of Sodium Triphosphate (D 501 – 55 T)

### Textile Materials (D-13)

*Methods of Test for:*
*Tensile Strength of Wool Fiber Bundles (D 1294 – 56 T)

*Methods of Identification of:*
*Fibers in Textiles (D 276 – 56 T)

*Methods of Test for:*
Nonlint Content of Cotton (Shirley Analyser Method) (D 1451 – 56 T)
Twist in Single Spun Yarns (Untwist-Twist Methods) (D 1422 – 56 T)
Twist in Single Spun Yarns (Direct-Counting Method) (D 1423 – 56 T)
Unevenness of Textile Strands (D 1425 – 56 T)
Tear Resistance of Woven Fabrics by Falling-Pendulum Method (D 1424 – 56 T)

### Soils for Engineering Purposes (D-18)

*Method of Test for:*
*Moisture-Density Relations of Soils (D 698 – 56 T)

### Industrial Water (D-19)

*Methods of Test for:*
Ammonia in Industrial Water and Industrial Waste Water (D 1426 – 56 T)
Sodium and Potassium Ions in Industrial Water and Water-Formed Deposits by Flame Photometry (D 1428 – 56 T)
Specific Gravity of Industrial Water and Industrial Waste Water (D 1429 – 56 T)
Residual Chlorine in Industrial Waste Water (D 1427 – 56 T)

### Plastics (D-20)

*Specifications for:*
Nonrigid Polyvinyl Chloride and Copolymer Molding and Extrusion Compounds (D 1432 – 56 T)
Polychlorotrifluoroethylene Molding and Extrusion Materials, and Methods (D 1430 – 56 T)
Styrene Acrylonitrile Copolymer Molding and Extrusion Materials (D 1431 – 56 T)
**Polystyrene Molding Compounds (D 703 – 56 T)
**Methacrylate Molding and Extrusion Compounds (D 788 – 56 T)

*Specifications for:*
*Cast Methacrylate Plastic Sheets, Rods, Tubes, and Shapes (D 702 – 56 T)

*Methods of Test for:*
Flammability of Flexible Thin Plastic Sheeting (D 1433 – 56 T)
Gas Transmission Rate of Plastic Sheeting (D 1434 – 56 T)
*Flammability of Plastics 0.050 in. and Under in Thickness (D 568 – 56 T)
*Flammability of Plastics 0.050 in. and Over in Thickness (D 635 – 56 T)

*Recommended Practice for:*
Outdoor Weathering of Plastics (D 1435 – 56 T)

### Wax Polishes and Related Materials (D-21)

*Method of:*
Test for Flash Point of Solvent-Type Liquid Waxes (D 1437 – 56 T)
Application of Emulsion Floor Polishes to Substrates for Testing Purposes (D 1436 – 56 T)

### Cellulose and Cellulose Derivatives (D-23)

*Methods of Test for:*
Pentosans in Cellulose (D 1438 – 56 T)
Sodium Carboxymethylcellulose (D 1439 – 56 T)

### Emission Spectroscopy (E-2)

*Method of:*
Spectrochemical Analysis of Pig Lead by the Point-to-Plane Spark Technique (E 117 – 56 T)

*Recommended Practice for:*
Photographic Processing in Spectrochemical Analysis (E 115 – 56 T)
Photographic Photometry in Spectrochemical Analysis (E 116 – 56 T)

### Chemical Analysis of Metals (E-3)

*Methods for Chemical Analysis of:*
Titanium and Titanium-Base Alloys (E 120 – 56 T)
Nickel-Chromium and Nickel-Chromium Iron Alloys (E 38 – 56 T), to be added when adopted to Standard Method E 38 – 56.
Copper-Tellurium Alloys (E 121 – 56 T)
Chromium-Copper Alloys (E 118 – 56 T)
Slab Zinc (Spelter) (E 40 – 56 T), to be added when adopted to Standard Method E 40 – 45.

*Photometric Methods for:*
Determination of Phosphorus in High-Phosphorus Brazing Alloys (E 56 – 56 T), to be added when adopted to Standard Method E 56 – 45.
*Chemical Analysis of Aluminum and Aluminum-Base Alloys (E 34 – 56 T)
*Chemical Analysis of Electronic Nickel (E 107 – 56 T)

*Methods for:*
Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron (E 30 – 56 T), to be added when adopted to Standard Method E 30 – 56.
*Chemical Analysis of Zinc-Base Die-Casting Alloys (E 47 – 56 T)

### Materials for Electron Tubes and Semiconductor Devices (F-1)

*Methods of:*
*Testing Sleeves and Tubing for Radio-Tube Cathodes (F 128 – 56 T)

*Specifications for:*
*Molybdenum Wire under 20 Mils in Diameter (F 289 – 56 T)

# Carbon Black and Casein Committees Organize at Atlantic City

## Six Subcommittees Formed in Carbon Black Committee

At its organizational meeting in Atlantic City on June 22, Committee D-24 on Carbon Black elected as its chairman, Sherman R. Doner of Raybestos Manhattan. The committee also elected as vice-chairman, C. A. Carlton of J. M. Huber Corp.; and secretary, A. G. Cobbe of Godfrey L. Cabot Co.

The committee approved the organization of six subcommittees and appointed chairmen as follows:

Physical Tests—Frank Svetlik
Chemical Tests—L. G. Mason
Optical Tests—H. A. Ambrose
Nomenclature—John Talant
Sampling—R. O. Treet
Coordination (with other committees): G. S. Garvey

### Suggested Methods Published

The 13 Methods of Test for Carbon Black, developed by the Carbon Black Industry Analytical Committee, have been submitted to Committee D-24 for consideration. These methods are published as information in this issue, beginning on page 51. The committee is also sponsoring the distribution of a number of reprints of these methods to interested groups in this country and abroad.

C. A. Carlton reported the results of an interlaboratory test program to evaluate the reproducibility of these tests. Several were found to be quite satisfactory and they will probably be balloted on by the committee in the very near future for recommendation to the Society as ASTM tentatives. Others require more development. Test methods other than those published in this issue to be considered by the committee include: surface area by nitrogen absorption, oil absorption, tinting strength, color, flow, sulfur determination, particle size, and wettability.

## Casein of primary importance to paper industry

Casein, as an engineering material, is used in a number of industries. Over 90 per cent of its total production is consumed by the paper industry, the remaining production being used mostly in the manufacture of leather, paint, adhesives, rubber and printing ink. The bulk of the production of casein centers in Argentina with Australia as a second important source.

A number of consumers of casein expressed to the Society the need for standard methods of test in this country and particularly because of the international trade aspects. Following initial contacts leading to a conference in January of this year, a new technical committee was authorized by the Board of Directors. The new committee held its organization meeting on June 20 during the ASTM Annual Meeting in Atlantic City. Although there was not a heavy attendance at this meeting, a very representative group of both producers and consumers discussed organizational matters and conducted its initial business.

The committee agreed upon the title and scope which was expanded from that originally proposed at the earlier conference to include soya protein and similar materials. The title of the committee agreed upon is Committee D-25 on Casein and Similar Protein Materials. The proposed scope now reads:

Definitions of terms and the study and formulation of test methods and specifications covering industrial casein, isolated soya protein, and similar proteinaceous materials.

The initial organization of the committee, reflecting the most urgently needed projects, will consist of an Executive Subcommittee and Working Subcommittees on Definitions of Terms, Sampling, Chemical Tests, Physical Tests, and Research. At a later date it is planned to add a Subcommittee on Specifications. Sampling and physical test methods appear to be the most needed fields of activity. Such physical properties as viscosity, solubility, strength, particle size, and foaming properties will be stressed initially. Additional physical test methods suggested will include dirt content, wet rub or water resistance of both film and coating, color or brightness of solution, odor, and coating tests, among others.

H. W. Shader, Armstrong Cork Co., who played a prominent part in the earlier deliberations on the formation of the committee, was elected chairman. The election of a secretary was deferred until the next meeting. Subcommittee chairmen appointed are as follows:

I on Definitions—R. W. Bell, U. S. Dept. of Agriculture
II on Sampling—J. C. Rice, Lowe Paper Co.
III on Chemical Tests—E. G. Stimpson, Natl. Dairy Research Labs.
IV on Physical Tests—L. E. Georgevitz, Borden Co.
VI on Research—L. E. Clark, Jr., Perkins Glue Co.

The membership of the new committee is still open and additional invitations will be extended.

The initial membership of the committee is composed of the following:

The organization meeting of Committee D-25 on Casein.

| | |
|---|---|
| *Producers* | |
| Avoset Co. | S. B. Gilpin |
| Borden Co. | L. E. Georgevits |
| Erie Casein Dryers | A. F. Reisenbigler |
| National Dairy Research Labs. | E. G. Stimpson |
| Sheffield Chemical Co. | J. R. Borst |
| Tupman Thurlow Chemical Co. | Joseph Brown |
| *Consumers* | |
| Armstrong Cork Co. | H. W. Shader |
| Certain-teed Products Co. | C. G. Shuttleworth |
| International Paper Co. | Albert E. Oetken |
| Lowe Paper Co. | John C. Rice |
| National Casein Sales | Elmer Bergey |
| National Gypsum Co. | D. G. Hamme |
| Perkins Glue Co. | L. E. Clark, Jr. |
| St. Regis Paper Co. | H. R. Hall |
| Stecher-Traung Lithographing Co. (consulting) | |
| Technical Assn. of Paper & Pulp Ind. Coating Committee | J. R. Rice |
| S. D. Warren Co. (Consulting) | J. J. Thomas |
| Watervliet Paper Co. (Consulting) | R. T. Trelfa |
| *General Interests* | |
| ASTM Committees | |
| Committee D-1 on Paint | R. L. Whitney (National Lead Co.) |
| Committee D-6 on Paper | W. R. Willets (Titanium Pigment Co.) |
| Committee D-14 on Adhesives | P. A. Macy (Perkins Glue Co.) |
| Spellacy, John R. | |
| Thwing-Albert Instrument Company | Edward J. Albert |
| U. S. Dept. of Agriculture | |
| Agriculture Research Service Dairy Products | E. O. Whittier, R. W. Bell |
| U. S. Dept. of Agriculture Forest Products Lab. | F. L. Browne |
| New York State College of Forestry | A. H. Bishop |
| Pennsylvania State University (consulting) | F. J. Doan |

## STEEL

Many important projects under way in Committee A-1 came to fulfillment at the time of the Annual Meeting. These are all covered in detail in the 60-page 1956 Preprint No. 1 *Report of Committee A-1 on Steel.*

Several proposed revisions were withdrawn from the report, including the addition of extra low-carbon grades of types 304 and 316 steel to Specifications A 213, A 249, and A 312 covering tubular products. The proposed revised mechanical properties of alloy steels in Specifications A 182 for forged or rolled fittings, pipe flanges, and valves for high-temperature service were withdrawn, as well as the revisions in Specifications A 383 for forged untreated carbon steel axles. All of these will be given further consideration before the Society is asked for publication approval.

The following information relates to activities of general interest within the area of standardization of steel products. They are all items on which producers and consumers alike have spent and are spending a tremendous amount of effort. The effort, however, is justified by the ultimate result in better products which are generally available.

In the structural field, a new high-strength, alloy rivet steel specification is being developed. This steel composition is intended for applications where rivet steel furnished to Specifications A 195 has proved unsatisfactory. Also a new high-strength structural steel is being studied, for which considerable data on static and fatigue strengths will soon be available. Task groups have been given assignments to prepare ASTM specifications for wire strand used for reinforcement of prestressed concrete units and structures, for plain and deformed steel rods rolled in coils for use in concrete reinforcement, and for special deformed billet steel bars used for concrete reinforcement (sizes Nos. 14 and 18).

For pressure-vessel work, three new specifications are to be prepared, paralleling the present Specifications A 201, A 212, and A 285 but containing an additional provision for low residual copper content. Also it was recommended that Specifications A 201, A 212, and A 204 contain an additional requirement to prohibit graphitization at high-temperature service. This clause states that when the steel is used at 750 F or above, the steel is to have added to it a maximum of $\frac{3}{4}$ lb of aluminum per net ton and should have a McQuaid-Ehn grain size of 1 to 4. Both of these developments are the result of requests from the petroleum industry for plate materials deemed necessary in the construction of processing equipment.

Task groups have presented final recommendations on proposed specifications for flange and firebox sheet steel and for hot-rolled carbon steel sheets of commercial quality. The specification for carbon steel sheets of flange and firebox qualities was a difficult one on which agreement could not be reached because of the procedure for sampling for determining mechanical properties. The project was an active one several years ago but was temporarily dropped until lately, for the reason stated.

A proposed recommended practice for ultrasonic testing and inspection of turbine and generator steel rotor forgings is in final form and may be published late this year. It should be noted that this document is very specific on the testing procedure since it is limited to a particular product.

In the field of tubular products, a new specification is to be written to supplant Case 1208 of the ASME Boiler and Pressure Vessel Code. This would cover special corrosion-resisting low-alloy steels

The Advisory Committee of Committee A-1 on Steel photographed at the Annual Meeting.

for economizer tubes in high-pressure boilers. Sufficient data now appear to be available on centrifugally cast pipe to warrant specifications. Accordingly a task group will write a draft for specifications for centrifugally cast ferritic alloy-steel pipe for high-temperature service.

## WROUGHT IRON

RESPONSIBILITY for the Standard Specification for Iron and Steel Chain (A 56 – 39) is being split by Committees A-1 and A-2, which formerly exercised joint jurisdiction. Committee A-1 is writing a proposed tentative specification for carbon steel chain which will be issued under a new designation number. The designation A 56 will be used by Committee A-2 to cover a new proposed tentative specification for wrought iron crane chain. This revised Specification A 56 is in its final form, undergoing letter ballot by Committee A-2, and is expected to be published late in 1956.

## NON-FERROUS METALS AND ALLOYS

THE four sessions of the Solder Symposium, sponsored by Subcommittee II of Committee B-2, attracted unusual interest. Judging from this interest, the strong attendance at all sessions, and the number of high-grade technical papers presented, this was one of the Society's most successful symposia.

A decision of general interest was to organize active groups to gather requirements for various of the unusual metals—including important metals in the reactor construction group. Tentative specifications can then be written promptly as the need justifies such action.

A symposium on titanium has been organized for the Los Angeles meeting in September. Consideration is being given to establishing a new Subcommittee of B-2 to cover titanium and its alloys.

A new proposed tentative specification has been drafted for secondary lead. A draft of a classification for tin is being circulated for final suggestions.

## CEMENT

THE application of mechanical mixing to the preparation of some cement mortars having been accomplished, studies have been made to promote wider application of this helpful technique. With some necessary modifications, it was reported at the meeting of Committee C-1 that the mechanical mixing procedure has been incorporated in the test for bleeding of cement pastes and mortars (C 243), and consideration is now being given to the application of mechanical mixing to the preparation of neat cement pastes. An extensive study has also been made of the use of the mixer in the preparation of tensile strength mortars.

The recently adopted tentative tests for flexural strength have been given much attention. The committee wishes to encourage the use of these test procedures, and several possible revisions are being contemplated as a means of promoting wider usage. A new series of cooperative tests has been set up to study the flexure tests and other related problems.

Among the interesting questions before the committee are matters related to the standard sands used in the preparation of mortars, the establishment of limits for calcium sulfate in mortar and limits for false set in cement, the need for stricter control of relative humidity in cement testing laboratories, and a new procedure for use in determining the air fineness of materials other than portland cement. Possible modifications in the time of set tests are being considered, and some revisions in the specifications for additions are being contemplated. The adoption of a desirable modification of the water retention test for masonry cement is being effected. The field study of problems related to the sulfate resistance of mortars, and also false set, are being continued.

**The meeting of the Advisory Subcommittee of Committee A-3. Left to right: G. A. Timmons, D. E. Krause, V. A. Crosby, H. W. Lownie, Chairman H. W. Stuart, Secretary T. E. Eagan, R. A. Clark, and J. S. Vanick.**

## MAGNESIUM OXYCHLORIDE AND OXYSULFATE CEMENTS

THE yield of oxychloride cements can now be determined and evaluated by means of an ASTM standard as a result of two proposed test methods approved by Committee C-2. The two methods include one field test for yield. The committee also approved for letter ballot the adoption as standard of Tentative Methods of Test for Ignition Loss and Active Calcium Oxide in Magnesium Oxide for Use in Magnesium Oxychloride Cements (C 247). The development of an abrasion test continues to be of interest.

## CHEMICAL-RESISTANT MORTARS

THE need for ASTM standards to cover membranes and sheet-type linings used in conjunction with brickwork in chemical-resistant mortars may lead to an expansion in the scope of Committee C-3. A task group will study this matter and report at the next meeting.

A recommended practice for installing sulfur mortar joints has been accepted for letter ballot, as a necessary supporting standard to the standard specification for sulfur mortar (C 287). The development of a method of test for chemical resistance of resin mortar continues to be a major objective with the problem being divided into three phases: (1) effect of chemicals on weight change; (2) visible observation of solutions; and (3) effect of chemicals on strength properties.

In the field of silicate mortars, final review of a method of test for the compressive strength of silicate mortars was completed and the draft will be submitted to the editorial subcommittee and to Subcommittee S-1 for inclusion in a specification. Definitions of chemical silicate setting cements of alkali types will be prepared for inclusion also in the specification. A proposed specification for resin cement mortars was reviewed with some changes made. Final draft will now be resubmitted for subcommittee ballot.

Meeting in Atlantic City—Committee A-6 on Magnetic Properties.

## LIME

The use of natural pozzolanic material with lime will be covered by an ASTM specification in the near future as a result of the consideration given to this material at the meeting of Committee C-7. Suitable test methods for determining the hydraulic properties of the natural materials need to be decided upon. This specification will be a companion to the new Tentative Specification for Fly Ash for Use as a Pozzolanic Material with Lime which was accepted at the Annual Meeting.

The round-robin testing program on autoclaving lime-cement mixtures with and without sand has now been completed and the data will be circulated to the committee.

Proposed specifications for lime used in the chemical industries received attention, these being for silica brick and sand-lime brick manufacture, and for use in hypochlorite bleach manufacture.

## CONCRETE

RESEARCH on the effect of longtime creep of concrete and a cooperative program on the pore-structure characteristics and requirements of aggregates was reported among other projects under consideration by the group of research subcommittees of Committee C-9. Other research projects on which progress is noted include a report on laboratory work by the Corps of Engineers on the kind and amount of fly ash as related to the potential reactivity of aggregates used in concrete. The modulus of elasticity in concrete in compression is being studied. Various pulse velocity test instruments are being reviewed as to their value as research tools.

In the test methods and specifications group, a proposed method for measuring the thermal coefficient of expansion of concrete has been prepared for publication as information. A draft is being prepared of a method of cement content of freshly mixed concrete, published earlier as information in the October, 1955, issue of the ASTM BULLETIN. A proposed specification for natural pozzolanic material has been approved in subcommittee and revisions in the existing specification for fly ash are proposed, raising the $SO_3$ content to 5 per cent. The resistance of concrete to abrasion has been under study for a long time as well as several methods for simulating this action. By subcommittee agreement, a shot-blast type of test is being prepared for consideration. A proposed specification for packaged, dry concrete and mortar mixtures, previously published as information, was approved for letter ballot of the committee. In addition to several minor revisions to the Tentative Specification for Concrete Aggregates (C 33) consideration is being given to certain manufactured sands in respect to their effect on slipperiness of pavements. A mechanical device for the drying of aggregates in the determination of lightweight pieces (C 123) will be recognized by a proposed method to be added to this tentative. A complete revision of the Standard Method of Test for Soft Particles in Coarse Aggregates (C 235) was approved for letter ballot. Tests will be made to establish further the effect of the $l/d$ ratio and size of specimen in lower strength lightweight concrete, based on present evidence of variation between the use of cylinders and cubes.

## MORTARS FOR UNIT MASONRY

The two specifications for mortar for masonry purposes (C 161 and C 270) received attention at the meeting of Committee C-12. A complete revision of the older specification, Tentative Specification for Mortar for Reinforced Brick Masonry (C 161) was accepted for letter ballot of the committee. A water-retention-test procedure was approved for inclusion in the Proportion Specifications section of the Tentative Specification for Mortar for Unit Masonry (C 270). Portland blast-furnace slag cement was also recognized as being a suitable type for use in this specification.

Cooperative tests on aggregates used in mortar are being continued. The Working Subcommittee on Efflorescence has been combined with Subcommittee II on Research and P. L. Rogers, Riverton Lime and Stone Co., has assumed the chairmanship of the combined group due to the death of F. O. Anderegg.

## MANUFACTURED MASONRY UNITS

The use of a weather index based on a map prepared by the U. S. Weather Bureau as a criterion for the waiver of durability requirements for clay building brick was accepted, subject to letter

Committee C-1 at the Annual Meeting.

ballot by the committee. This new criterion replaces the present requirement of the average annual precipitation of less than 20 in. The new system provides a more accurate measuring stick based on experience over the last sixty years in determining the average rainfall during the winter months, rather than on a year-round basis, the critical freezing-and-thawing period, of course, being during the winter months.

Sulfur capping was recognized as a satisfactory material in preparing brick for testing and was proposed as a tentative revision of Standard Method C 67.

Two new specifications on types of chemical-resistant masonry units were reported in varying stages of completion; one for industrial floor brick is essentially complete and will be sent to manufacturers for comment; the other is for ceramic power packings. The latter specification will include definitions of certain materials, shapes and sizes, and tolerances. An extensive industry-research program is under way on clay filter block, which the committee will follow with interest, looking toward future use of the test data.

Revisions were approved for the three standard specifications for concrete masonry units (C 90, C 129, and C 145) consisting of the addition of a paragraph in the section on visual inspection to include units used in exposed wall sections. Committee C-9 will be asked to consider a revision of Tentative Specification for Concrete Aggregates (C 33) to make it applicable for use in concrete block. A method for determining the moisture content of hardened concrete by the relative humidity method was discussed.

As reported in the past, the difficult task of inaugurating the development of standards in the field of waterproofing materials for unit masonry walls continues. A cooperative program of collecting test data on materials, including silicones, has been inaugurated and standards prepared by the National Research Council of Canada are being reviewed. A task group will study the objectives and scope in an effort to determine the types of methods to be developed, either using panels or the materials themselves.

## ASBESTOS-CEMENT PRODUCTS

The preparation of a new specification for asbestos-cement sewer pipe progressed considerably as a result of a meeting of Committee C-17. The determination of completeness of cure will receive special attention as a research method for use in connection with the proposed specification. It is hoped that the draft of the proposed specification will be completed by the time of the next meeting of the committee.

The determination of organic fibers will be covered in a proposed method of test to be prepared by the Subcommittee on Test Methods. Handleability continues to be studied by this subcommittee.

**The Editorial Board, Joint Committee on Chemical Analysis by Powder Diffraction are left to right: Benjamin Post, F. W. Matthews, H. F. McMurdie, F. H. Gillery, A. S. Beward, S. Weissmann, L. G. Berry, G. W. Brindley, and H. W. Rinn.**

## PAINT, VARNISH, LACQUER

Committee D-1 and 80 of its subcommittees and working groups held meetings over a three-day period highlighted by a panel discussion on floor finishes.

The committee withdrew from its report the recommendation for revision and reversion to tentative of the standard Specifications for Copper Phthalocyanine Blue (D 963 – 49). Two test procedures included in this revised tentative require further study.

The preparation of metal surfaces for paint testing has been under study by the committee for several years. Variations in surface treatment produce end conditions which differ and which do not necessarily yield identical results when paints are applied. Service conditions dictate the type of surface preparation that should be selected, although the quality produced by any individual method may vary with different alloys. Two methods were described this year, one for preparation of aluminum and aluminum-alloy surfaces and the other for magnesium alloy surfaces for painting. The former covers four types of treatments involving solvent cleaning, chemical, anodic, and mechanical treatments. The procedure for preparation of magnesium surfaces includes two classes of treatments, chemical and anodic. These methods of preparation are intended primarily for panel specimens for testing, although it is understood that some of these same treatments are being used commercially.

The Tag Open-Cup Flash Point Test for Volatile Flammable Materials (D 1310 – 55 T) has been the subject of a cooperative study by nine laboratories. The data resulting from these cooperative tests, covering the period from July, 1955, to February, 1956, are presented in the current report. The Tag Open Cup method is widely used in commerce for testing volatile flammable materials having flash points below 175 F. A value in excess of 80 F by this method has been established by the Interstate Commerce Commission as the minimum value for classifying liquids as nonflammable. Materials having a flash point at or below that value must be identified with an ICC Red Label for interstate shipment by common carrier within the U.S.A. There was also presented this year a new flash point test (D 1393) for vegetable drying oils commonly used in paints and varnishes.

The measurement of dry film thickness of paint is important, not only on test panels but also for commercial applications. A new method presented this year covers procedures using an inductance thickness gage and a penetration thickness gage. These methods provide procedures for nondestructive measurements of thickness of electrically nonconductive dry films of paint, varnish, lacquer, and related products when applied over a nonmagnetic metal base.

Another important method was the test for abrasion resistance of clear floor coatings such as lacquer, varnish, and related finishes.

## PETROLEUM PRODUCTS AND LUBRICANTS

Committee D-2 for the fifth consecutive year had the distinction of submitting to the Society the largest report, totaling 150 pages. Still another indication of the extensive activity of this committee was the 120 meetings of D-2 divisions, technical committees, and subcommittees held over the entire six days of the Annual Meeting.

The committee withdrew from its report, as preprinted, the recommendation for adoption as a standard of the Tentative Method of Test for Penetration of Petrolatum (D 937 – 49 T). Changes were made in several other recommendations and these were accepted subject to favorable retroactive letter ballot of the committee of those revisions which involve substance changes. The details of these revisions will be given in the Summary of Proceedings which will be distributed to the Society membership during the summer.

Procedures for calibrating tanks for various shapes and sizes have occupied the attention of the committee for the past seven years. The first of these was published in the ASTM Manual on Calibrating Liquid Containers which covers the detailed procedures for upright tanks (D 1220 – 52 T). Five companion methods have now been completed for the following types of containers: (1) liquid calibration of tanks, (2) barge tanks, (3) stationary horizontal tanks, (4) spherical and spheroidal tanks, and (5) tank cars.

Eleven proposed methods of test were submitted for publication as information only for trial use during the coming year. These covered such subjects as: (1) oxidation test for turbine oils, (2) sulfur in petroleum products by the rapid, high-temperature combustion method, (3) active sulfur in cutting fluids, (4) hydrocarbon types in gasoline by mass spectrometry, (5) density and specific gravity of viscous materials and melted solids by Bingham pycnometer method, (6) density and specific gravity of hydrocarbon liquids by Lipkin bicapillary viscous oil pycnometer, (7) low-temperature torque of ball-bearing greases, (8) filterability of jet fuels, (9) color of lubricating oils, (10) high-temperature anti-friction-bearing grease tester, and (11) thermal stability of boiler fuel oil, based on the Bureau of Ships test (12) extension of the octane number scale.

Two appendices to the Tentative Method of Gaging Petroleum and Petroleum Products (D1085) were submitted for publication as information. These cover the design and operation of automatic gaging devices, and measurement of tanks containing plastic foam blankets.

A very important revision was made this year in the Tentative Method of Test for Ignition Quality of Diesel Fuels by the Cetane Method (D 613 – 48 T). This revision provides for the use of the Ignition Delay Meter, Model ECS-1, in place of the present coincident flash method of instrumentation. This Ignition Delay Meter consists of four electromagnetic pickups, main chassis, and meter, which are used for the detection and measurement of ignition delay in testing diesel fuels. In approving this change in the Cetane Method it was necessary to provide sufficient time for manufacture and distribution of the ignition delay meter. Provision has accordingly been made for this revision to become effective on June 1, 1957.

At the annual dinner of Committee D-2 the guest of honor was R. C. Alden, chairman of the Research Planning Board, Phillips Petroleum Co. Mr. Alden, first vice-chairman of Committee D-2, has long been an active member of a large number of technical committees and research divisions of Committee D-2.

### MOTOR FUEL RATING METHODS:

The Motor and Research methods for determining the knock characteristics of motor fuels was completed by Committee D-2 during the year and have just been published by the Society in the 1956 ASTM Manual for Rating Motor Fuels. The new Manual includes the Motor Method D 357 and Research Method D 908 in their latest revised forms. Also included are six extensive appendices giving detailed information regarding the apparatus, reference materials, operation, maintenance, installation and assembly, and building and utility requirements.

Two other companion Manuals for rating fuels are in preparation. The next to make its appearance will be a Manual containing the Supercharge Method D 909 and the Aviation Method D 614, together with detailed appended material covering the operation and maintenance of these engines. The third Manual will be devoted to the Cetane Method D 613 for determining the ignition quality of diesel fuels. It is expected that these two new Manuals will be available in 1957.

### Significance of ASTM Tests for Petroleum Products

The third edition of "Significance of ASTM Tests for Petroleum Products" was completed by Committee D-2 this year. This publication presents an outline of the current ASTM Methods of Tests for Petroleum and reviews their relation to the performance characteristics of specific products. It has been prepared specifically for those who wish to acquire a general idea of the significance of the various ASTM methods prepared by Committee D-2 that apply to the evaluation of petroleum products, including lubricants and crude petroleum. The language has been kept relatively free of technical terms for those who may not be acquainted with such terminology.

## ELECTRICAL INSULATING MATERIALS

At the Atlantic City meeting, Committee D-9 approved the establishment of Subcommittee XV on Research and Technical Papers, with L. B. Schofield, chairman. This subcommittee replaces the former special Subcommittee on Technical Papers. Committee D-9 has long been active in research on insulation problems where solutions have been necessary to devise adequate test methods. This research has covered the entire area of responsibility of the committee with particular emphasis on the problems of Subcommittee IV on Insulating Oils, and the general testing problems covered by Subcommittee XII on Electrical Testing. Research problems of particular interest currently are concerned with corona testing, high-current arc resistance, tracking resistance, and thermal capability of insulating materials.

The committee accepted an invitation of Committee D-20 on Plastics to participate jointly in the group concerned with the effect of nuclear and high energy radiation on plastics, D. S. Ballantine, chairman.

In view of the many insulation problems confronting the aircraft industry and the relatively small representation of this industry on Committee D-9, members from this industry in a position to contribute to its activities are being solicited.

The committee gave official sanction to Subcommittee XI on Significance to include in its scope statistical quality control as it relates to determining properties of insulating materials.

## RUBBER

Highlight of the meeting of Committee D-11 was the dinner in honor of Arthur W. Carpenter who retired as Secretary of the committee after twenty-eight years service in that capacity. Mr. Carpenter was presented with a gift as a token of the appreciation of his many services to the committee over this long period. The excellent attendance at the dinner evidenced the high esteem in which Mr. Carpenter is held by his committee associates.

**Arthur W. Carpenter, retiring after many years of outstanding service in the Rubber Committee, was honored at a dinner given by the Committee.**

An added technical feature of the meeting was the presentation of two technical papers:

Measurement of Elastomer Hardness at Low Temperatures, by Max Hanok, New York Naval Shipyard

Test Design for Decision, by E. M. Bader, B. F. Goodrich Co.

The outstanding accomplishment of the committee this year was the completion of five new tentatives covering synthetic elastomers and rubber latices. Work on these materials was undertaken by the committee following the decision by the Government to dispose of its synthetic rubber facilities to private industry. This transfer made it necessary for the purchasers of the Government plants and those concerned with the commercial use of their production to assume responsibility for future standardization activities. Committee D-11 offered its services in this connection and as a result a new Subcommittee XIII on Synthetic Elastomers was established. The five new tentatives cover: (1) Nomenclature for Synthetic Elastomers and Latices, (2) Description of Types of Styrene Rubbers (SR), (3) Description of Types of Styrene Rubber (SR) and Butadiene Rubber (BR) Latices, (4) Chemical Analysis of Synthetic Elastomers (Solid Butadiene-Styrene Copolymers), and (5) Sampling and Physical Tests for Synthetic Rubber Latices (Butadiene-Styrene Copolymers).

At its meeting the committee decided to expand the nomenclature for synthetic elastomers and to enlarge the description of types of styrene rubbers in order to provide for further classifications within each producers group.

Committee D-11 also authorized Subcommittee XIII to act for it in the assignment of code numbers when the materials covered change from the status of new polymers to regular production materials.

Committee D-11 has taken an active part in the work of Technical Committee 45 on Rubber, of the International Organization for Standardization. One of the first accomplishments of this activity is the recommendation this year of a new ASTM Tentative Method of Test for International Standard Hardness of Vulcanized Natural and Synthetic Rubbers (D 1415-56 T). This method is based on the measurement of the penetration of a rigid ball into the rubber specimen under specific conditions. The measured penetration is converted into International Rubber Hardness degrees, the scale of degrees being so chosen that 0 represents a material having an elastic modulus of zero, and 100 represents a material of infinite elastic modulus.

Committee D-11 is extending an invitation to ISO/TC 45 to hold its next meeting in the United States in 1959. This meeting would be held in Akron, Ohio, in November in conjunction with another international meeting planned by the Rubber Division of the American Chemical Society during the week of November 8, 1959, in Washington, D.C. This Washington meeting will be held in cooperation with the ASTM and the Committee on Plastics and Rubber of The American Society of Mechanical Engineers.

A new Tentative Recommended Practice for Interlaboratory Testing of Rubber and Rubber-Like Materials (D 1421) was accepted as tentative. This tentative was prepared in response to requests from D-11 subcommittees for recommendations to be used as a guide in planning interlaboratory test programs. This recommended practice is intended to define the statistical concepts that are likely to be involved in the design of an interlaboratory test, and to give the basic principles involved in the planning of an interlaboratory test if it is desired to make the data susceptible to statistical analysis and interpretation.

Important revisions were made this year in the Standard Specifications for Woven Jacketed Rubber-Lined Fire Hose for Public and Private Fire Department Use (D 296).

## TEXTILE MATERIALS

Committee D-13, the largest ASTM Committee, was reorganized during the year through the establishment of separate subcommittees dealing individually with: (1) Fiber Test Methods, (2) Yarn Test Methods, (3) Fabric Test Methods, and (4) Chemical and Performance Test Methods. This change in the organization of the committee has greatly facilitated its work as indicated by the current report which contains 27 recommendations affecting standards, of which five are new tentative methods.

Two important additions were made this year to the series of ASTM test methods for testing and evaluating cotton fibers. All of these test procedures for cotton are under consideration by the ISO Technical Committee 38 on Textiles and accordingly they have world wide significance. The two new procedures cover a new Tentative Method of Test for Non-Lint Content of Cotton (Shirley Analyser Method)(D 1451); and a Proposed Method of Test for Strength of Cotton Fibers Using a Finite Gage Length (Flat Bundle Method). The Shirley Analyser Method is applicable to cotton separated from the seed by either a saw or roller gin. Samples of cotton drawn from the press-box, bale, or picker lap are tested for non-lint content by the Shirley Analyser. The technique is also applicable to processing waste removed in ginning, opening, cleaning, picking, and carding.

Two new methods for determining the twist in single spun yarn were issued this year as tentative. One of these, the untwist-twist method, is intended for use when only approximations of twist in single spun yarns, expressed in terms of turns per unit length, are required. This method is not recommended as a research or acceptance test because its results reflect appreciable errors under some conditions, due

to a lack of knowledge of the proper tensions to use.

The second procedure, which is a direct-counting method, determines the twist in single yarns in terms of turns per unit length and direction. The method is applicable to spun yarns, composed of natural or man-made fibers, or combinations thereof. The procedure is designed primarily for packaged yarns but, with special precautions, it may be used for yarns taken from fabrics.

The important property of evenness or unevenness of textile strands has occupied the attention of the committee for several years. Completed this year was a new Tentative Method of Test for Unevenness of Textile Strands (D 1425). Unevenness is calculated from data obtained by measurements of strand properties related to linear density. Two main principles of measurement and types of instrument are used for determining unevenness, as follows: (1) measurement of variations in compressed cross-sectional areas of the strand, and (2) measurement of variations in those properties of the strand which change the capacity of a condenser when the strand passes between its plates.

Tear resistance of textile fabrics is another characteristic that has been under study by the committee. This has resulted in a Tentative Method of Test for Tear Resistance of Woven Fabrics by Falling-Pendulum Method (D 1424). This method of test employs the falling-pendulum method for determining either the average force or the average energy required to propagate a tear starting from a cut in a woven fabric. The method is applicable to treated and untreated fabrics, including those heavily sized or coated.

The development of the new "man-made" or synthetic fibers has presented additional problems in identification where it is desirable to analyze a fabric made of several fibers. Studies have been conducted over the past several years on procedures for identifying these newer fibers. New methods of analysis are included this year in the revised Standard D-276 for identification of fibers in textiles. These methods cover procedures for the identification of 33 different textile fibers used commercially in the United States. The procedures used include: (1) microscopic examination, (2) staining characteristics, (3) density of fabrics and their solubility in different reagents, and (4) methods of reagent application for fiber separation.

The Standard Definition of Terms Relating to Textile Materials (D 123) was revised to include a chart which shows in outline form the classification of major fabrics used for textile purposes. Included also are new tentative definitions for "natural fiber" and for "man-made fiber."

## SOILS FOR ENGINEERING PURPOSES

Much activity was reported in the field of stabilization with admixtures. The Section on Soil-Cement Stabilization is planning to prepare a suggested method of making and curing soil-cement compression and flexure test specimens in the laboratory. Test methods are also planned for determining flexural strength of soil-cement mixtures using simple beam apparatus with third-point loading. Suggested methods for compressive strength of soil-cement mixtures using portions of beams broken in flexure and for compressive strength of molded soil-cement cylinders will also be developed. The new Section on Soil Conditioners has in mind materials which would modify soils and improve them for engineering purposes, such as affecting permeability.

The Section on Calcium Chloride is sponsoring a method of test for determining chlorides in soils, a method already approved by Committee D-4. The Subcommittee on Pile Load Bearing Tests has reviewed existing standards with changes being considered which will tend toward more accurate loading. A lateral test method and the determination of group capacity of piles are two other projects in this subcommittee.

In the study of physical properties of soils, revision of procedures on soil capillarities and permeabilities is being reviewed and the subcommittee will concentrate on the revision of these methods in order that they may appear in the new edition of the "Soil Procedures." A report on a series of tests on maximum and minimum density of granular materials was given.

A special subcommittee spent considerable time in discussing the policy which should be pursued by the committee in the preparation of methods of testing soils. The use of recommended practices was discussed but in most cases found inappropriate on the basis that the procedures used would definitely be in the category of test methods. More attention will be given to the preparation of a suitable scope in each method which will more clearly indicate how the method is to be used and evaluated in terms of each particular condition and soil location.

An interesting paper was presented at the close of the business meeting by Bonner S. Coffman, Engineering Department, District of Columbia. The paper presented a practical and rapid method for predetermining the accuracy of the in-place density test using sand-cone apparatus.

## INDUSTRIAL WATER

The committee reported on the status of a number of new projects, among the more significant a micro method for silica and a colorimetric micro method for chloride ion, the latter being particularly applicable to high-purity water systems such as in nuclear power plants.

A new project on measurement of radioactivity in industrial water and industrial waste water was initiated.

Committee D-19 on Industrial Water meeting in Atlantic City.

Performance tests on ion-exchange materials were considered and should soon be ready for publication.

A comprehensive group of proposed methods for appearance properties of industrial water was included in the report of the committee.

## PLASTICS

THE ORGANIZATION meeting of a new section on the effects of nuclear and high-energy radiation on plastics was held on June 19, as a part of Subcommittee V on Permanence of Committee D-20 on Plastics. The chairman of the new radiation group is D. S. Ballantine of Brookhaven National Laboratories who has been working for several years studying the effects of nuclear radiation on plastics. The scope of the new group is the development of methods of irradiation and testing to determine the effects of nuclear and high-energy radiation on the physical and chemical properties of plastics. Committee D-9 on Electrical Insulating Materials has accepted an invitation to participate in the radiation studies and has requested that it be a joint activity of the two committees.

The radiation problem was only one of a large number of matters actively considered at the meeting of the Plastics Committee. Stress-cracking is a characteristic of polyethylene which has been found rather difficult to evaluate, and the committee intends to submit for publication as information, a draft describing the best currently available procedure for determining stress-cracking with a discussion of the limitations of the method and significance of the results.

Projects of the Joint Committee on Plastic Pipe (with SPI) nearest completion concern dimensional standards and material specifications for polyvinyl-chloride pipe and a quality standard including dimensions and tolerances for cellulose acetate butyrate pipe.

The committee is evaluating a suggested test method for snag resistance of plastic film. The test originally developed for coated fabrics was described in the ASTM BULLETIN (December, 1955—*TP226*).

Cellular Plastics is the subject of a newly organized subcommittee which held its first meeting on June 19. Considerable interest in this subject is indicated. The scope of the subcommittee covers development of specifications for raw materials, and specifications and test procedures for expanded cellular plastics. Sections were authorized covering cellulosic, epoxy, isocyanate, phenolic, urea, vinyl, polyester, silicone, styrene, polyethylene expanded plastics. Chairman of the new subcommittee is I. J. Stoneback of Federal Telecommunications Laboratories.

W. A. Zinzow, former vice-chairman, was elected an honorary member of the committee in recognition of his long and outstanding service to the committee.

## METHODS OF TESTING

A new Subcommittee on Microchemical Apparatus was organized during the year, its personnel consisting of the Committee on Microchemical Apparatus of the Division of Analytical Chemistry of the American Chemical Society. Consideration will be given to the entire field of microchemical apparatus including glassware, metalware, filters, etc. The design of microchemical apparatus is, in general, closely related to and determined by its manner of use. Later, it may be found desirable to undertake the development of microchemical methods.

The Subcommittee on Microscopy sponsored an informal discussion on noncommercial microscopic accessories. The discussion provided an opportunity for microscopists who have developed accessories for the optical or electron microscope, or for preparation of samples, to describe such equipment for the information of other interested members. Such informal sessions provide an excellent opportunity for a general exchange of information by those working in this technical field regarding improvements in apparatus and accessory equipment. This was the second annual session of this type, and the committee plans to sponsor a similar session at the 1957 Annual Meeting.

An organization meeting of a new task group on laboratory balances was held under the chairmanship of L. B. Macurdy, chief of the Mass Unit, Mass and Scales Section, National Bureau of Standards. The committee reviewed a draft of proposed requirements which will serve as a basis for specifications for analytical balances.

The committee sponsored jointly with the Society of Rheology an informal presentation of eight papers on various complex rheological problems.

Committee E-1 has plans under way for a symposium on particle-size measurement which it hopes can be arranged in time for the 1957 Annual Meeting of the Society.

## CHEMICAL ANALYSIS OF METALS

The committee held a very active series of meetings of the main committee, its subcommittees, and task groups, to take care of the last material for the forthcoming edition of the "Book of ASTM Methods for the Chemical Analysis of Metals."

Presented in the report of the committee were six new methods, among the more important being methods for the analysis of titanium and its alloys, copper-tellurium alloys, and chromium-copper alloys. Revision of eight standards and tentatives were also covered.

It is expected that the new edition of the Book will be published about the end of this year.

## METALLOGRAPHY

THE Annual Meeting program included two committee meetings which were primarily concerned with obtaining the views of the copper and brass industry (as represented by Committee B-5) on the Tentative Method for Determining the Average Grain Size of Metals (E 112–55 T) published by the Society and sponsored by Committee E-4. Method E 112 is intended to supplant eventually the present grain size methods E 19, E 79, E 89, and E 91 covering a variety of ferrous and nonferrous metals and alloys.

While the other industries appear satisfied with the new E 112, the copper and brass industry still has reservations that all the provisions of Method E 79, which is referenced extensively in the ASTM copper and copper alloy specifications, are suitably included in the new Method E 112. Committee E-4 is anxious to obtain over-all approval of the new method and intends to revise Method E 112 in accordance with the wishes of Committee B-5 just as soon as Committee B-5 can transmit its suggestions.

## NONDESTRUCTIVE TESTING

OF PARTICULAR interest to manufacturers and purchasers of iron and steel castings should be the development of a set of reference photographs of magnetic particle indications on ferrous castings. A task group consisting of representatives of Subcommittee III of ASA Sectional Committee B 31, the Manufacturers' Standardization Society of the Valve and Fittings Industry, the Steel Founders' Society, and ASTM presented a set of these photographs to Committee E-7 at its June 22 meeting. It was endorsed with enthusiasm and the committee agreed to conduct an immediate letter ballot on approval for publication by ASTM. The photographs depict varying degrees of severity of linear discontinuities (cracks and hot tears), shrinkage, inclusions, internal chills, and unfused chaplets, porosity, and weld defects. They were collected by the Steel Founders' Society from its member companies. Also included in

the set are examples of false indications and magnetic anomalies. The reference photographs are intended for use when specified in contracts, orders, material specifications or codes, and when the limiting class of severity is mutually agreed upon by the manufacturer and the purchaser. Publication date has tentatively been set for September or October, 1956, if the committee ballot is favorable.

Committee A-3 has petitioned Committee E-7 to prepare reference radiographs of the discontinuities peculiar to nodular iron and cast iron in general. This work will be done, since it has been found that the Reference Radiographs E 71 for Steel Castings cannot be easily used for cast or nodular iron.

## QUALITY CONTROL

The round-table discussion on statistical aspects of ASTM specifications sponsored by Subcommittee I of Committee E-11 on Quality Control was very well attended. Three informal papers introduced the session:

Comment on Applying Statistical Requirements in ASTM Standards, by Frank Grubbs, Ballistics Research Laboratory.

Acceptance Provisions in Some ASTM Specifications and Their Relationship to Buyer-Seller Relations, by W. R. Pabst, Jr., Vice-Chairman, Subcommittee I.

Analysis of Quality Control Provisions in ASTM Specifications and Suggestions for Improvement, by Oliver Beckwith, Fabric Research Laboratories.

This round-table discussion was arranged in order to provide an opportunity for members of the Society, and particularly of the technical committees, to discuss mutual problems in the field of statistical analysis and quality-control techniques.

## APPEARANCE

Committee E-12 has prepared a list of the Definitions of Appearance Terms now published in ASTM methods which it plans to submit to all technical committees of the Society for review to determine whether the list adequately covers all the terms needed for their particular materials. An effort will then be made to eliminate unnecessary terms, and revise others where necessary.

The committee has under study the feasibility of undertaking the preparation of a Manual on Appearance Properties of Materials. It is proposed that such a Manual might include detailed information on dimensions of appearance, instruments of appearance valuation, instruments of operation, appearance measurement practice in different industries, and terms and definitions. It is planned to canvass the technical committees of the Society to determine whether there is sufficient interest in such a Manual to warrant its preparation.

A discussion session on "The Value of Consumer Interests in Defining Appearance Problems" was held at the April 4 meeting of Committee E-12 in New York City. In general, the discussion indicated that "consumers" for Committee E-12 represent a wide range of purchasers of engineering and engineered materials. These purchasers range from intermediate manufacturers through fabricators to the ultimate consumer. Their major contribution toward improving selection of Committee E-12 activities lies in the identification of specific scales of measurement that they use and define in matters of appearance. These scales can well be quantified and improved by the committee. On the other hand, specific values on these scales, while of interest to these purchasers, are not within the authority of the committee to determine. To improve the performance of Committee E-12, it is planned to assess the activities and personnel of the committee toward a better investment of time and energy. It is possible that more worthwhile problems, or a better balance of existing problems and of types of personnel, could be obtained from positions in commerce and in industry which are close to these classes of customers.

## Summary of Proceedings and Letter Ballot

THE Summary of Proceedings of the Annual Meeting, setting forth the actions taken at the meeting will shortly be placed in the mails to all members in good standing. It will be accompanied by a letter on all recommendations calling for formal adoption as standard. The ballot is to be canvassed September 12.

### *September 1—Last Day for Annual Meeting Papers Discussion*

WRITTEN discussion of papers and reports presented at the Annual Meeting will be received by the Committee on Papers and Publications until September 1. In view of the fact that much of the discussion published in the *Proceedings* is submitted after the meeting by letter, it will be helpful if all who can will send in their discussion to Headquarters well in advance of this date so that additional time is available to review and refer the discussion to authors for closure.

**Members of the E-7 Executive Council are left to right: Hamilton Migel, N. A. Kahn, Secretary Alexander Gobus, Chairman J. H. Bly, Vice-Chairman D. T. O'Connor, and C. H. Hastings.**

# NEW ASTM PUBLICATIONS

## *Symposium on Speed of Testing*

A SYMPOSIUM on Speed of Testing sponsored by ASTM Committee E-1 on Methods of Testing was held at the ASTM Annual Meeting in June, 1955. The papers and discussions arising from this meeting are now available as an ASTM Special Technical Publication.

The effect of speed of testing on metallic materials is well covered in the literature, but reliable data on the effect of testing speed on some nonmetallic materials are less adequate. The seven papers in this publication represent a vast stride toward filling this gap. Here the field is wide because of the tremendous variability in the response of glass on one hand and rubber on another. The testing speeds employed as reported in these papers range from very slow to very fast straining rates.

Included in the symposium are the following papers:

The Influence of Rate of Loading on the Strength of Wood and Wood-Base Materials—*L. J. Markwardt and J. A. Liska, U. S. Forest Products Laboratory*

The Effect of Speed of Testing on Glass—*H. N. Ritland*

The Effects of Speed in the Mechanical Testing of Plastics Testing—*A. G. H. Dietz and F. J. McGarry, Massachusetts Institute of Technology*

Stress-Strain Relationships in Yarns Subjected to Rapid Impact Loading—*H. F. Schiefer, J. C. Smith, F. L. McCrackin, and W. K. Stone, National Bureau of Standards*

Effect of Speed of Testing on the Tension Test of Elastomers and Hard Rubber—*D. C. Scott, Jr., Scott Testers, Inc., and D. S. Villars, Naval Ordnance Test Station*

Review of Data on Effect of Speed in Mechanical Testing on Concrete—*D. McHenry and J. J. Shideler, Portland Cement Assn.*

Notes on Effect of Speed of Testing on Tensile Strength and Elongation of Paper—*R. E. Green, Thwing-Albert Instrument Co.*

Copies of this 92-page publication, *STP 185*, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. Price, $2.50; to members, $1.85.

## *Methods for Reducing the Effect of Barometric Pressure in Measurement of Octane Number*

THE latest revisions of ASTM Research Method D 908 as set forth in the new ASTM Manual for Rating Motor Fuels by Motor and Research Methods, specify changes in engine inlet-air temperature and compression ratio when fuels are rated at other than standard sea-level barometer. The modified operating conditions are a partial result of lengthy investigations of the barometric pressure rating variation problem inherent in the ASTM Motor (D 357), Research Method, and Aviation Method (D 614).

A complete record of the project to establish and alleviate the problem is given in a paper by Bruno R. Siegel published as ASTM *Special Technical Publication 186*. This publication presents all data obtained in two altitude-chamber tests conducted by Research Division I of ASTM Committee D-2 at the National Bureau of Standards with the support of the Petroleum Products Committee of the API Division of Refining.

The maintenance of "standard knock intensity" has long been recognized as a primary requisite for reproducible knock testing methods. This led to the use of "Guide Curves" which prescribed the compression ratio to be used for a given octane number-reference fuel blend. As the effect of barometric pressure on this relationship became recognized, a series of altitude-chamber tests (1941) developed the proper compensations in compression ratio required to maintain standard knock intensity even at high altitude; and these were used for 15 years.

However, the production of more temperature-sensitive fuels, the general use of primary reference fuels, and the adoption of a detonation meter in place of the "bouncing pin" were contributing factors in the creation of a rating variation problem. While other operating variables often obscured this in the field, tests conducted in the altitude chamber in 1949 established that the degree of such rating variation was intolerable. A pressurized carburetor was built which permitted operation at a standard inlet air pressure at altitudes up to 10,000 ft. Altitude-chamber tests conducted in 1952 proved that pressurizing equipment would solve the problem but that it would be inherently troublesome.

Since the mechanical solution left much to be desired from a functional viewpoint, attention centered on another solution which theory offered: that is, the time, temperature, density theory held that if burning time were held constant, a fuel would detonate at specific compression temperature-density combinations, irrespective of the operating conditions which might be used to create such a particular temperature-density relationship.

It was reasoned that, in the first place, ratings did not vary because of lower manifold pressure at reduced barometric pressure but because the knock intensity so lost was regained by changing compression ratio only, thereby changing both temperature and density. It seemed reasonable to suppose, therefore, that ratings would not be affected by barometric pressure if sea-level temperature–density conditions could be maintained by proper adjustments in both compression ratio and inlet-air temperature.

The 1953 altitude-chamber tests were designed to explore this approach. It was soon found that, because of other fundamental limitations of the methods, conventional compression formulas could not be applied. They did not restore the knock intensity lost by lowering ambient air pressure. Proper compression ratio-inlet air temperature combinations were therefore developed for the Research method by trial and error using several cylinder assemblies. The averaged results were combined in a convenient table for routine use. Extensive field tests proved the table valid, whereupon Committee D-2 and the Society balloted favorably for its inclusion in the method.

The same approach was used in an attempt to develop similar corrections for the Motor method. The table so developed was successful in keeping the ratings of nonleaded fuels in line at all barometric pressures. Leaded fuels, however, were overrated at high altitude. It is theorized that the high surface temperature of the mixture heater blades required to maintain 300-F inlet

temperature at sea level initiates lead decomposition so that not all of it reaches the engine effectively. Prescribing lower inlet temperatures with a resultant substantial reduction in heater blade surface temperature in high altitude therefore allows more of the lead to reach the engine effectively and this, in turn, causes the leaded fuels to be overrated. Efforts to overcome this limitation of the motor method are continuing.

The Research method revisions are considered significant from several viewpoints. First, they overcome a long-standing and aggravating limitation of the method currently used for rating motor fuels. Second, in other (petroleum) laboratory investigations made subsequent to these tests, it has been found that changes in inlet-air temperature and compression ratio can be used to balance out manifold pressure differences of 60 or more in. of mercury in the same manner that 6 to 10 in. of mercury differences (in barometric pressure) are balanced out for the research method. Third, it also has been found that the conventional compression formulas can be applied when evaluating fuels in an ASTM engine if the fuel-air ratio is held constant, if peak power spark is maintained, and if electrical input to the mixture heater is limited.

It is gratifying to note, therefore, that the results of the altitude-chamber tests, in addition to isolating and solving the immediate problem, opened new avenues of thought which may result in the development of auxiliary test methods for studying fuel behavior and engine fuel requirements on a more fundamental basis.

Copies of this publication can be obtained from ASTM, 1916 Race St., Philadelphia, Pa. for $1.50; to members, $1.15.

## Elevated Temperature Properties of Coppers and Copper-Base Alloys

THE publication, sponsored by the Data and Publication Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals, makes available a graphical summary of the elevated-temperature strength data for coppers and copper-base alloy. This publication follows four similar publications on steels and alloys which have been well received by fabricators, designers, and research workers in these fields. The data include summary curves for modulus of elasticity; tensile strength; yield strength (0.5 per cent extension and 0.2 per cent offset); per cent elongation and reduction of area; stresses for rupture in 100, 1000, 10,000, and 100,000 hr; and stresses for creep rates of 0.0001 and 0.00001 per cent per hr. This publication, 248 pages, paper cover, can be obtained for $5.50; to ASTM members $4.25.

## Standards and Data on Electrical Insulating Materials

THIS latest edition of the compilation of standards on electrical insulating materials, sponsored by Committee D-9 on Electrical Insulating Materials, includes specifications and test methods issued by the Society covering various types of materials in this field. The changes since the previous edition issued in 1955 comprise 12 revisions and 2 new items covering methods of testing silicone insulating varnishes and a recommended practice for cleaning plastic specimens for insulation resistance testing. Included are 83 methods of test and specifications.

There are also included two appendices, one giving proposed recommendations for writing statements on the usefulness of tests of electrical insulating materials and the other proposed methods of test for dielectric constant and dissipation factor of aviation fuels. Data on the officers and personnel of the committee are also included.

This publication makes readily available in convenient form, widely used specifications and test methods for the following materials used in the electrical and electronics industries:

Insulating Shellac and Varnish
Plates, Sheets, Tubes, Rods and Molded Materials
Mineral Oils for Electrical Insulation
Ceramic Products
Solid Filling and Treating Compounds
Insulating Fabrics and Papers
Mica Products

The compilation also includes a number of electrical tests and conditioning requirements for electrical testing, which are generally applicable to insulating materials.

All testing and research engineers, purchasers of electrical insulating materials, and other technologists in the electrical and related industries should find the latest edition of this complete volume of considerable interest and assistance.

These standards—642 pages in heavy paper covers—may be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. Price, $6.00; to members, $4.50.

## ASTM Standards on Engine Antifreezes

THE THIRD edition of the compilation of Standard Methods of Testing Engine Antifreezes comprises nine methods and two specifications, including the new Tentative Procedure for the Glassware Corrosion Test of Metals by Engine Antifreezes (D 1384 – 55 T). Although the glassware corrosion test is a popular method of evaluating engine antifreezes, it is intended as a screening test only. The proper evaluation of engine antifreezes may only be based upon the results of tests in dynamometer engines, or mechanical bench equipment capable of equivalent service simulation, and finally by road tests in vehicles. Thus the glassware corrosion test will be followed in the future by more definitive methods. This compilation, 56 pages in heavy paper covers, can be obtained from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa., price: $1.50; to members, $1.15.

### Printing Error in Standard Specifications for Pig Lead

A VERY misleading printing error has occurred in the 1955 revision of the Standard Specifications for Pig Lead (B 25–55). The chemical requirements for acid copper lead in Table I include a value of 0.040 per cent, maximum, for silver plus copper. This should be deleted from the table, since it was never intended that such a value be included. Specifications B 29–55 appear in the following books:

*1955 Book of ASTM Standards*, Part 2. p. 71.
*ASTM Standards on Copper and Copper Alloys*, December, 1955, p. 71.
*ASTM Standards on Metallic Electrical Conductors*, December, 1955, p. 74.

ADMINISTRATIVE COMMITTEE ON STANDARDS

# Actions on Standards

April and May 1956

## Steel

**Tentative Specifications for Billet Steel Bars for Concrete Reinforcement (A 15 – 54 T) (Approved May 2, 1956).**

As a result of cooperative testing, Committee A-1 has found it to be possible to impose more severe bending tests on intermediate and hard grades of billet steel bars and has accordingly revised Table IV—Bend Test Requirements for Deformed Bar—to show these increased requirements.

**Tentative Specifications for Welded Steel Wire Fabric for Concrete Reinforcement (A 185 – 54 T) and (A 185 – 37) (Approved May 2, 1956).**

The 1937 standard is withdrawn in favor of the 1954 tentative which is revised to bring it more closely in line with current industry practice.

**Tentative Specification for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement (A 305 – 53 T) (Approved May 2, 1956).**

In order to prevent improper application of the specification to bars or bar sizes outside its scope, Section 3(*e*), in the tabulation of minimum height of deformation, is revised to change the listing of deformed bar designation number from the present "6 and over" to "6 to 11, in."

## Filler Metal

**Tentative Specification for Nickel and Nickel-Base Alloy Bare Welding Filler Metals (B 304 – 56 T) (Approved April 10, 1956).**

These specifications developed by the Joint AWS-ASTM Committee on Filler Metal cover bare filler metals for welding of nickel and high-nickel alloys containing more than 50 per cent nickel by the oxyacetylene, atomic hydrogen, inert-gas metal-arc (nonconsumable electrode) inert-gas metal-arc (consumable electrode) and submerged arc welding processes.

**Tentative Specification for Surfacing Welding Rods and Electrodes (A 399 – 56 T) (Approved April 10, 1956).**

These new specifications cover straight-length bare and covered surfacing rods for use with the manual gas, inert-gas metal-arc (nonconsumable electrode), carbon-arc and atomic hydrogen welding processes; also straight-length bare and covered surfacing electrodes for use with the manual metal-arc welding process.

No attempt has been made to classify all filler metals within these limits. The specification covers only those filler metals which have approximate industrial standardization and for which technical data were available. A list of other commonly used filler metals is given in the Appendix and it is intended that they will be included in subsequent editions of these specifications.

**Tentative Specification for Welding Rods and Covered Electrodes for Welding Cast Iron (A 398 – 56 T) (Approved April 10, 1956).**

These new specifications cover filler metals suitable for welding gray cast iron, malleable iron, and some alloy cast irons.

## Rubber and Rubber-Like Materials

**Tentative Method of Test for Stress Relaxation of Vulcanized Rubber in Compression (D 1390 – 56 T) (Approved May 2, 1956).**

This new method measures the decrease with respect to time of the back stress exerted by compressed rubber and is especially significant in evaluating gasket materials. Developed at the Materials Laboratory of the U. S. Navy Bureau of Ships, it has been used there successfully for several years. It was described to Committee D-11 with extensive test data and has been subsequently checked in other laboratories.

**Tentative Specification for Rubber Insulating Sleeves (D 1051 – 49 T) (Approved May 2, 1956).**

Revised to provide for additional sizes and styles of sleeves in line with present commercial practice; some test procedures are clarified and aging requirements slightly modified.

**Tentative Specification for Construction of Rubber Insulated Wire and Cable (D 1350 – 54 T) (Approved May 2, 1956).**

Revised to make mandatory the use of a protective tape between metallic shields and insulation and to bring the thickness of nonmetallic sheaths into agreement.

**Tentative Recommended Practice for Conditioning of Elastomeric Materials for Low-Temperature Testing (D 832 – 46 T) (Approved May 2, 1956).**

Completely rewritten to incorporate research results of the past ten years in the field of low-temperature behavior of rubber.

## Atmospheric Sampling and Analysis

**Tentative Method of Test for Odor Concentration in Air and Gases (D 1391 – 56 T) (Approved April 2, 1956).**

It is believed the standardization of this method which has been in use for some time should go far toward providing industry and enforcement groups with a "common language" for consideration of odor problems. This method establishes a quantitative concept of odor whereby the relative quantities of odor from two or more different sources, or from the same sources under different operating conditions, can be compared. Since it depends upon the human olfactory sense, it is subject to variations of this sense among persons and at different times. Accuracy and reproducibility of results can therefore be increased by increasing the number of observers.

# ACR Notes

Administrative Committee on Research

## The Newly Discovered Fact

By R. C. Alden

MR. NASON, in the May, 1956 BULLETIN, used an intriguing expression: "We seldom let an accepted conclusion stand in the way of a newly discovered fact."

Why are we so disrespectful of accepted conclusions? Why are we so interested in the newly discovered fact? And what relation does this have to ASTM?

Perhaps the aphorism, "The customer is always right" is the keynote to standardization and progress in the U.S.A. It is this attitude which spurs our industry and commerce in the constant search for new and improved products and for new uses for these products. Our standardization begins with the needs, and even the whims, of the consumer. There is a strong likelihood that far more standardization is achieved *via* purchases and purchase orders than is ever achieved by accepted conclusions as expressed by existing standards.

In an environment of this kind the national standardization must be dynamic and flexible. No "standard" can be the last word and all "standards" must bow to newly discovered facts.

The American Society for Testing Materials, with its fundamental purpose "to promote knowledge of engineering materials" and with its organization plan for bringing producers, consumers, and general interests together in a common democratic form, is an ideal agency for the dynamic national standardization necessary in this ever-changing and ever-progressing interplay of materials.

It is a mammoth undertaking requiring unstinting efforts of all the works in the Society to be alert to newly discovered facts as related to the standards which are brought under the surveillance of the Society. The great prestige enjoyed by ASTM standards bespeaks the success of this effort.

Nevertheless there are large and significant gaps in our knowledge of the properties and behavior of engineering materials. It is the hope of the Administrative Committee on Research that through its efforts the numerous technical committees will sponsor research in these areas.

It is encouraging to note that many of the technical committees include "research" as one of their functions in their scopes. More often than not, however, the technical committees become engrossed in their day-to-day problems and the research function is postponed to some future date. It is, therefore, one of the suggestions of the Administrative Committee on Research to technical committees that their Subcommittees on Research be activated, enlarged, and encouraged.

## Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

| DATE | GROUP | PLACE |
|---|---|---|
| September 11–13 | Joint ASTM-TAPPI Committee on Petroleum Wax | Madison, Wis. (Loraine) |
| **September 16–22** | **Second Pacific Area National Meeting** | **Los Angeles, Calif. (Statler)** |
| September 17 & 19 | D-23 on Cellulose and Cellulose Derivatives | Atlantic City, N. J. (Haddon Hall) |
| September 17–19 | D-22 on Atmospheric Sampling | Atlantic City, N. J. |
| September 18–19 | C-8 on Refractories | Manns Choice, Pa. (White Sulphur Springs Hotel) |
| September 27 | C-21 on Ceramic Whitewares and Related Products | Bedford, Pa. (Bedford Springs Hotel) |
| October 2–3 | C-22 on Porcelain Enamel | Columbus, Ohio (Battelle Memorial Inst.) |
| October 4–5 | B-5 on Copper and Copper Alloys, Cast and Wrought | Hershey, Pa. (Hotel Hershey) |
| October 8–9 | B-9 on Metal Powders | Cleveland O. (Hotel Manger) |
| October 15–17 | D-29 on Plastics | St. Louis, Mo. (Chase Park Plaza) |
| October 16–19 | D-13 on Textile Materials | New York, N. Y. (Warwick) |
| October 17–19 | D-9 on Electrical Insulating Materials | St. Louis, Mo. (Chase Park Plaza) |
| October 18–19 | B-8 on Electrodeposited Metallic Coatings | Philadelphia, Pa. (Benj. Franklin) |
| October 22–23 | B-1 on Wires for Electrical Conductors | Washington, D. C. (Sheraton Park) |
| October 23–24 | D-10 on Shipping Containers | St. Louis, Mo. (Statler) |
| October 29–31 | C-16 on Thermal Insulating Materials | Williamsburg, Va. |

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RACE STREET
PHILADELPHIA 3, PENNA.

## Ten Organizations Unite for Methods Review

NINE organizations became charter members of a new Joint Committee on Uniformity of Methods of Water Examination at a meeting in Biloxi, Miss., on January 26, 1956. Since that date, another has joined the group. The harmony and agreement of thought reached at this meeting opened the door to the establishment of close cooperation among the principal organizations that prepare, adopt, and publish for general public distribution water examination methods which are in general use.

The recommendations of this committee will be advisory only and will not supplant or impede the work and publication policies of any participating interest.

The purpose of the committee is to secure uniformity of content of these methods by providing a mechanism for exchanging information among member organizations; securing uniformity of terminology; and reviewing methods with respect to objectives, sampling, apparatus and reagents, procedure, reporting of results, and application. The methods reviewed will include those covering natural water, potable water, industrial water, industrial waste water, and sewage.

Charter members include the Committee on Disposal of Refinery Wastes of the American Petroleum Inst., American Public Health Assn, American Society of Mechanical Engineers, American Society for Testing Materials, Association of Official Agricultural Chemists, Federation of Sewage and Industrial Waste Assns., Manufacturing Chemists Assn., Technical Association of the Pulp and Paper Industry, and the United States Public Health Service (R. A. Taft Sanitary Engineering Center). The Geological Survey (U. S. Dept. of the Interior) was elected to membership on April 24, 1956.

The first officers of the new committee, elected to serve two years beginning with March 1, 1956, are: chairman, F. W. Gilcreas, representing APHA; vice-chairman, A. Thurn, representing TAPPI; and Secretary, C. K. Rice, representing ASTM.

Applications for committee membership by any nonprofit organizations that are interested in joining the effort toward uniformity of water methods and that can qualify under the committee's Regulations may be mailed to the Secretary. His address is: Refinery Technology Laboratory, Gulf Oil Corporation, P. O. Box 7409, Philadelphia 1, Pa.

This should be the answer to a problem that has plagued the laboratory man for many years. JCUMWE (pronounced ja-kum'-wee) should be the instrument whereby a test by one "standard method" will provide the same answer as the equivalent test by any other "standard method."

**ASTM exhibit of publications at the National Association of Purchasing Agents' "Inform-A-Show" at the Cleveland Auditorium. This booth provided an opportunity for some 7000 purchasing agents throughout the country to see and learn about the Society's research and standardization activities plus the great number of materials specifications available for use by industry. The backboard displays some of the many special standards which complement the ASTM Book of Standards.**

## X-Ray Diffraction Committee Chairman Retires After 15 Years of Leadership

WHEELER P. DAVEY, the guiding spirit for over 15 years of the internationally recognized X-ray diffraction data card file, has resigned his dual jobs as editor-in-chief of the card file and as chairman of the Joint Committee on Chemical Analysis by X-ray Diffraction Methods. This effort is presently sponsored by the American Crystallographic Assn, the Institute of Physics (British), the National Association of Corrosion Engineers, and the American Society for Testing Materials.

In 1940, as a member of the (then) National Research Council Committee on X-ray Diffraction, Dr. Davey was among the first to recognize the great potential value of the "Hanawalt Method" as a powerful analytical tool in the chemical and metallurgical field. He was also cognizant of the fact that sponsorship of this method could be best accomplished with the backing of ASTM. Thus, in the formative days of the present Joint Committee, the project was initiated under the auspices of ASTM and the NRC, with Dr. Davey being unanimously chosen for the leading role.

In the beginning, there seemed to be little hope that the Joint Committee would succeed in its project to collect, edit, and publish X-ray diffraction data for use in chemical analysis. The committee had the offer of the use of the original Dow Chemical Co. data but neither the facilities nor the finances to proceed with the work.

Wheeler P. Davey

After repeated attempts to obtain a "home" or headquarters for this work—all to no avail—it was finally through the personal efforts of Dr. Davey that the Pennsylvania State University (with which he was then affiliated) was finally persuaded to permit the use of its facilities. Also, one of the deciding factors which led the General Electric X-Ray Corp. to underwrite the financing of the publication of the first set of data cards was the high esteem in which Dr. Davey, as a former member of the General Electric Research Laboratory Staff, was held by his associates.

As one of the early developments in the project, it was through the sole efforts of Dr. Davey that the Institute of Physics (British) became a partner in this work, and has been the largest individual contributing organization to the data file.

During the earlier years before financial reserves had been established, all of the work at Penn State was *gratis*. As the finances increased and the work load became exhaustive, paid assistants were employed. However, throughout all this period, and even in the more recent years of his retirement from Penn State, Dr. Davey never received payment for his services which, for some time amounted to nearly full-time work.

With thousands of data cards in use, world-wide distribution of data and international sources of new data, the pre-eminent position of the card index is definitely established.

The success of the Joint Committee has been Dr. Davey's chief aim and practically full-time job for over a decade. He has earned a rich reward in the hearts of his coworkers and high esteem from those who use the data.

The new editor-in-chief of the card file is G. W. Brindley, The Pennsylvania State University, University Park, Pa. The new Joint Committee chairman is H. W. Rinn, The Dow Chemical Co., Midland, Mich. Dr. Davey has been named honorary chairman for life of the Joint Committee.

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## Conference on Low Temperature Engineering

THE 1956 Cryogenic Engineering Conference will be held September 5, 6, and 7 in Boulder, Colo. The second meeting of its kind in this important new field, the conference will be devoted to engineering problems in the low-temperature range, that is, below 150 K (−190 F). The first conference was held at Boulder in September, 1954, as part of the dedication program of the Boulder Laboratories of the National Bureau of Standards.

The technical papers and discussions will deal with engineering research and development at very low temperatures. Among the topics to be covered are bubble chambers, instrumentation, properties of materials, insulation, and cryogenic equipment and processes.

The field of cryogenic engineering is growing rapidly, as larger and larger quantities of the liquefied gases, such as hydrogen, oxygen, nitrogen, and helium, are being used by industry and national defense, and for laboratory research. This has necessitated the design and construction of safe, large, and more efficient equipment for producing and using them. Unusual engineering problems are encountered because of the marked differences in the behavior of materials at very low temperatures as compared with ordinary temperatures.

Information regarding registration and reservations may be obtained from P. L. Barrick of the NBS Cryogenic Engineering Laboratory, Boulder, Colo.

## Patent Office Examiners Needed Immediately

ENGINEERS and scientists are needed immediately as Patent Examiners by the U. S. Patent Office, Washington, D. C.

Patent Examiners pass upon applications for patents in a wide range of technical fields. The job keeps them in close touch with the latest developments in these fields.

Salaries start at $4345 per year and it is possible to reach $7570 in five and a half years. Vacations and sick leave and pension benefits are liberal.

The positions call for a college degree in engineering or applied science or a college degree with a major in chemistry or physics or with certain combined credits in these fields. There is no examination.

For further information, address the Commissioner of Patents, Washington 25, D. C.

The head table at Detroit, left to right: District Vice-Chairman C. O. Durbin; J. F. Leland; Executive Secretary R. J. Painter; District Chairman R. B. Saltonstall; President Fellows; A. R. Carr, Dean of Engineering, Wayne University; ASTM Director J. M. Campbell; and District Secretary Robert Sergeson.

# District Activities

## DETROIT

### *President Fellows at Homecoming Detroit Meeting*

ABOUT 200 members and guests in President Fellows' home city of Detroit greeted him enthusiastically at the District Meeting at the Rackham Building on Wednesday evening, April 25. Preceding his District address on Research in the Electric Power Industry, was an informal dinner at which District Chairman R. B. Saltonstall, The Udylite Corp., presided. Executive Secretary, R. J. Painter, the coffee speaker, noted the activity in District technical and administrative ASTM affairs down through the years and expressed the confidence this would continue. He briefly described the President's 10,000-mile West Coast trip praising ASTM's many District officers, members, and friends in the West who made the meetings a success.

The Executive Secretary stressed the fact that ASTM was a society for materials and noted some of the new areas into which it is moving with important new committees such as casein, carbon blacks, and consideration of problems in the field of nuclear energy applications.

At the Technical Meeting, J. F. Leland, Parker Rust Proof Co., chairman of the Prize Award Committee, presented the students (see accompanying photograph) to President Fellows for their membership certificates. In this case two were given, one from the Society and a special certificate from the Detroit District Council.

Detroit Edison men with President Fellows, left to right: Harvey Wagner; F. J. Walls; Claire Fellows, Director of Engineering Laboratory and Research Dept.; E. R. Moore, Manager of Engineering; W. G. Meese, Assistant Director Engineering Laboratory.

President Fellows made an effective presentation covering significant areas of work in the generation, transmission, and distribution of power. The talk, which it is expected will be published in the ASTM BULLETIN is not only of interest technically but, as a whole, provides very effective testimony of the value to industry of the work of ASTM and shows how industry supports its activities. In a separate news article, mention is made of an award of merit to Harry R. Wolf, General Motors Corp., while the national officers were in Detroit.

Above, Pittsburgh District Councillors with the national officers. Below, a number of the wives of the officers and councillors who attended the meeting.

## PITTSBURGH

### *Social Night and Student Awards*

FEATURES of the social evening in honor of President C. H. Fellows in Pittsburgh on April 26 were the presence of a large number of ladies, and the presentation of Student Membership Awards sponsored by the District Council. Council Officers, headed by Chairman Henry A. Ball, Ball Chemical Co., vice-chairman, Charles H. Sawyer, Eastern Gas and Fuel Associates, secretary, A. L. Johnson, Universal-Rundle Corp., and other Councillors, made earnest efforts to elicit the interest of the members and their wives. This resulted in an excellent attendance. There were short comments by the President and Executive Secretary, the principal ceremony being the award to students of membership in the Society. E. M. Kipp, head of the Research Division of the Kipp Research Laboratories, chairman of the Award Committee, was assisted by a councillor who presented each student to the President.

Pittsburgh Student Award winners. Seated, left to right: J. E. Huffman and R. L. Smith, University of Pittsburgh; T. S. Wiley, West Virginia Univ.; C. F. Seaman, Carnegie Institute of Technology. Standing, G. W. King, West Virginia Univ.; J. H. Shellhammer, Carnegie Inst.; Owen Richmond, Penn State.

## NEW ENGLAND

### *Zay Jeffries and President Fellows Speak at Amherst*

THE ANNUAL "College" meeting sponsored by the New England District in collaboration with a leading University in that area was held on Friday, May 4, at Amherst with the University of Massachusetts as host. Features were the major address by

Dr. Zay Jeffries, former Director of the Society and one of America's outstanding metallurgists and scientists, and President C. H. Fellows' presentation of a condensed version of his talk "Research in the Electric Power Industry." Mr. Fellows' talk has been noted in previous BULLETINS and is to be published in a later issue. An interesting talk by a senior at the University, John R. McKee, described the electrical features of an unusual ultrasonic centrifuge used for evaluating bursting speeds of high-speed rotating machinery and for other applications.

Dr. Jeffries' talk was of keen interest and concerned that most vital topic, "Metals for Defense"—our supplies of these, their strategic importance, etc. His remarks were based largely on experiences in the war period when Dr. Jeffries played an important part as a member of the Materials and Metals Advisory Board and subsequently the Materials Advisory Board. He stressed that an abundant supply of any metal eases the strain on all other metals. He noted the significance of engineering teams in these studies and the fact that when such teams are broken up to use some of the individuals in another capacity or company, it may be more damaging than constructive. Examples were given of the speeding up of research and development work when, as in wartime, there is a sharing of our research information. In one instance, an estimate that at least five to six months would be required to get an answer actually was shaved to about a month when investigators got most of the information from two or three different sources and finally found an individual whose reputation had not been widely heralded but who had been working on a related problem for several years and who supplied the rest of the answer. He mentioned the significance of conservation and substitution, particularly in World War II, through the work of the War Production Board. He noted that when we evaluate just how much we really need of a metal, such as tin, we can, under exigencies, reduce the normal requirements from, say 100,000, to 12,000 to 15,000 tons. Reference was made to the marked change in the columbium situation where we have a much better supply. Manganese was discussed, and it was noted that we have a great supply of low-manganese ores which, in an emergency, would suffice. Dr. Jeffries said we are in an age of quality metallurgy and some of our metals, for example, nickel, are important in most all of the high-grade alloys and therefore will be in continuing great demand. Concerning competing materials, such as plastics and steels, we are in an era of counter-current flow of interests and there will be changing demands and ways to meet them.

Engineering Dean George Marston presided at the dinner meeting. He commented on some aspects of engineering education problems, including the urgent need for more engineering faculty men. This is one of our most crucial situations because without competent teachers we cannot expect to produce an adequate supply of engineers, either in number or quality.

Dr. Shannon McCune, Provost of the University of Massachusetts, who had spent considerable time abroad, with many of his early years in Korea, and who later traveled extensively for the Government, described some of the pressing problems with the teeming population in Asia and the Pacific Islands.

**Some of the ladies who attended the Amherst meeting. Seated, left to right: Mrs. M. P. White; Mrs. E. N. Downing; Mrs. C. G. Lutts; Mrs. R. J. Painter; Standing at right is Mrs. R. A. Pomfret.**

**University of Massachusetts meeting. Seated, left to right: Engineering Dean George Marston; President Fellows; Provost Shannon McCune; New England District Chairman C. G. Lutts. Standing: Executive Secretary R. J. Painter; District Vice-Chairman Daniel Cushing; District Secretary R. W. Chadbourn; and R. P. Mahan new District Secretary.**

# Technical Committee Notes

## Electrical Heating, Resistance and Contacts

### *Electrical Contacts Found Sensitive to Speech, Hand-clap*

For several years efforts to develop a reproducible test for surety of make of electrical contacts have been unsuccessful because of difficult-to-control and elusive variables. Interlaboratory tests using standardized procedures have not yielded results meeting expectations. According to a report by P. N. Bossert, of Union Switch and Signal Co., to the Electrical Contacts Subcommittee of Committee B-4, identification and control of these variables may be in the offing.

Extremely thin films of corrosion products or other contamination on the contact surfaces presumably are the source of difficulty, since they impair direct metal-to-metal contact. Dr. Bossert conceived a method for measuring the a-c component of thermal resistive notice across a d-c contact, associating high values of noise with film conduction. Using a sensitive oscilloscope to measure thermal noise components across a d-c contact, he was able to show that despite careful vibration isolation of the contact assembly, noise components were generated by talking nearby or by a moderate hand-clapping 3 ft away.

Silver contacts were practically free from "sound" effect at 3-g force, whereas tungsten and copper showed it at contact forces as high as 30 g. These findings are significant in that they probably reveal the source of poor reproducibility in interlaboratory tests. It is believed that a more reproducible test could be devised by restricting testing conditions to avoid the sound effect phenomenon. This may require higher forces than previously used.

Other reports on contact investigations indicated that contacts are sensitive to vibration, impact and electromagnetic radiation and these factors must also be taken into account in devising a standard test.

The committee sponsored a symposium on electrical contacts at Pennsylvania State University during the week of June 24, 1956. A similar symposium was sponsored by the committee at this locale in 1954.

The committee is also actively developing methods of test and specifications for heating and resistance materials and thermostat metals. A new standard method of tests for thermostat metals was published with the 1956 Annual Report of the committee.

At its meeting in Swampscott, Mass., on June 13, the committee unanimously elected to honorary membership on the committee F. E. Carter, Baker & Co. (retired), P. H. Brace, Westinghouse (retired), and R. D. Van Nordstrand, Wilbur B. Driver Co.

## Acoustical Materials

### *Effect of Paint on Acoustical Tile*

The problem of preserving the sound-absorption efficiency of acoustical tile materials was discussed at some length at the meeting of Committee C-20 on Acoustical Materials, held at ASTM Headquarters on May 3. A test program being conducted at the National Bureau of Standards, using the impedance tube method as a means of evaluation, was reviewed by the Subcommittee on Maintenance under the chairmanship of W. C. Clark, Public Buildings Service. This program is being sponsored by the Public Buildings Service; the National Paint, Varnish, and Lacquer Assn.; and the Acoustical Materials Assn. The program is scheduled for completion in July. It is an attempt to study the effect of paint on acoustical tile, the objective being to establish the best paint with respect to covering ability and acoustical properties and the best type of tile that can be painted with a minimum of reduction in acoustical properties.

A further draft of a proposed tentative method of flame resistance of acoustical materials was distributed to the members. This method is a modification of the method described in Federal Specification SS-A-218b. Classification of acoustical materials used primarily as interior finishes is determined by this method, with four classes being established in terms of the flame spread on the material. One problem arising is that of standardizing on the fuel used. A questionnaire will be circulated among the users of the testing equipment to establish information on the type of gas used, geometry of the burner, size of orifice, and other details. A round-robin test series will also be conducted with the primary purpose of determining the Btu consumption in the test. The small tunnel test work at the Forest Products Laboratory and the radiant panel test at the National Bureau of Standards are being followed with interest by the committee.

With the recommendation to the Society of the test method involving the use of the impedance tube as a means of measuring sound absorption, a round-robin test series is planned to check the method using a standard sample. The reverberation chamber method, which has been under consideration for some time, continues to be studied in an attempt to establish reproducibility of test results.

In the consideration of other properties than sound absorption, a proposed air flow resistance method has been prepared and distributed for study. The Baumgartner Sphere test for light reflectance was discussed at some length. Contact will be made with all interested parties including the National Bureau of Standards, the originator of the apparatus, and users, for advice and suggestions on the factors which need to be controlled in the operation of this type of test. It was stressed that maintenance of the sphere is an important item.

The Subcommittee on Application reported that no satisfactory accelerated aging test method on adhesives had been found as yet. However, a proposed specification for acoustical adhesives will be sent to subcommittee letter ballot. A task group has been formed to investigate the mechanical suspension of acoustical tile.

## Ceramic Whiteware

### *Sections on Cermets and Ferrites Formed*

Sections on cermets and ferrites have been formed in Committee C-21 it was reported at its meeting on April 23 in New York City, held in conjunction with the Annual Meeting of the American Ceramic Society. The

new Section on Cermets, T. S. Shevlin, Ohio State University, chairman, will review as its first project, all existing ASTM standards, as well as other industrial standards, relating in any way to cermet problems. A proposed definition of the term "cermet" was agreed upon:

*Cermet.*—A coherent heterogeneous combination of metal(s) or alloy(s) with a ceramic or metalloid phase(s).

At the organization meeting of the Section on Ferrites with George Economos, Massachusetts Institute of Technology, as chairman, the definition of the word "ferrite" was discussed but no definition was agreed upon. Currently used methods in this field, are being assembled in order to provide a basis for discussion of the section at the next meeting.

A proposed method of test for crazing resistance of fired glazed whitewares by autoclave treatment and a proposed method of determining compressive strength of ceramic whiteware were given final review and upon the completion of the present testing program will be presented to the Society. The interlaboratory program for the technique of particle analysis of whiteware clays has been completed. This program studied in particular the electrolyte concentration for the hydrometer technique measuring particle size up to 1 micron.

Progress reports on whiteware clay methods included those of modulus of rupture, bond strength, and hydrogen ion concentration measurement. Control tests for barium titanates have been established after considerable laboratory work. These tests define chemical analysis, determination of ceramic and electrical properties, and X-ray examination.

## Mass Spectrometry

### *53 Papers Presented Before 300 Persons in Attendance*

THE Fourth Annual Meeting of Committee E-14 on Mass Spectrometry was held May 28 to June 1, 1956, in the Netherland Plaza Hotel, Cincinnati, Ohio. In addition to meetings of the main committee and the several subcommittees, papers sessions were held on each of the five days, with a total of 53 papers being presented before the more than 300 persons who attended the meetings.

Progress was reported on a project for soliciting pure compounds, obtaining spectra of the compounds, and making the spectra available for publication, through suitable media. Publication of mass spectra by the Society is not planned at present. A punched card system for indexing all published mass spectra, similar to the current ASTM systems for indexing absorption spectra and X-ray diffraction data, is being developed by the committee.

Performance requirements for mass spectrometers are being studied. The committee is attempting to set up a practice by which the mass spectrometer suitable for use in a given method of test can be specified in terms of performance characteristics determined on prescribed test mixtures, so as to eliminate need for specifying particular makes and models. Committee E-14 is cooperating with other ASTM technical committees in the incorporation of such apparatus specifications in new and revised mass spectrometry methods.

Among the more significant groups of papers presented was a symposium on mass spectrometry of solids. It is anticipated that this group of papers will be published by the Society. Also of special interest were several papers on one of the newer types of mass spectrometers—the cycloidal-focusing spectrometers. Many other phases of applied and theoretical mass spectrometry also were covered.

## Electron Tubes and Semiconductor Devices

### *Electronics Group "Matches Impedance" In Swampscott*

MEETING on June 14 and 15 at the Hotel Preston, Swampscott, Mass., Committee F-1 reported progress on a variety of active projects. Projects on luminescent and semiconductor materials account for most of these new additions. The luminescent and semiconductor materials groups have a common problem in the measure of particle size, the interests of both lying in a particle-size range of 2 to 10 $\mu$. Existing ASTM methods have been investigated and have been found not completely satisfactory. The two groups will coordinate their activities on measurement of particle size.

Excellent progress was reported in an interlaboratory test program for measuring wet adhesion of luminescent materials as used in cathode-ray tubes.

The semiconductor group is developing tests for germanium oxide, including resistance and rectification characteristics, volatile matter, and fluffiness. It is interesting to note that this industry uses the metric system for indicating weight and that materials are sold by the kilogram, the current price running in the neighborhood of $500 per kg.

The group on insulators is currently evaluating a number of grades of mica for suitability for use in electron tubes. Results of several laboratories' evaluation of mica samples will be consolidated to determine the degree of correlation of test methods used. A new project of the insulator group requested by several companies concerned with alumina ceramics will be to devise standard methods of test for determining the ultra-high-frequency dielectric and loss properties of alumina ceramics for electron tube applications.

Current projects of the cathodes group include revision of the interface impedance method (F 300) and the nickel cathode sleeve specification (F 239). The analytical group of the cathode subcommittee will work with the luminescent and semiconductor groups in developing the necessary wet chemical and spectrographic methods. New projects of the cathodes group just getting under way are concerned with determination of adhesion between coating and cathode, and the development of tests suitable for materials used in high voltage and pulsed tubes. The committee is also developing a standard triode device for evaluating all the materials used in electron tubes.

Officers appointed by the Directors for the organization of the committee in 1955 were elected at the Swampscott meeting to serve for the next two years. They are: S. A. Standing, chairman; F. J. Biondi, vice-chairman; and Stanton Umbreit, secretary.

## Compatibility Testing of Lubricating Greases

COMMITTEE D-2 on Petroleum Products and Lubricants has approved the following statement prepared by its Technical Committee "G" on Lubricating Grease:

"Compatibility of lubricating greases implies compatibility in service. Owing to the complexity of service problems, there is no single test which can be used to satisfactorily evaluate compatibility in general.

"Present ASTM methods, such as those for Dropping Point, Worked Penetration, and Leakage Tendencies of Automotive Wheel Bearing Greases may be used to test mixtures of greases as well as to test individual greases. Results obtained on such mixtures, as compared to results on the unmixed compound greases, are indicative of the compatibility of the mixtures. However, simple bench tests such as these must be correlated with a particular set of service conditions before a valid estimate of compatibility in such service can be achieved."

# Methods of Testing Carbon Black

## (Published as Information)

A NUMBER of procedures for testing carbon black prepared by the Carbon Black Industry Committee are being made available to the Society's Committee D-24 on Carbon Black. They are being published as information herewith for the purpose of soliciting comments and suggestions which will be referred to the committee in connection with its consideration of the methods. Comments should be addressed to the secretary of the committee, A. G. Cobbe, Cabot Carbon Co., Inc., Box 1101, Pampa, Tex.

### PELLET SIZE DISTRIBUTION OF CARBON BLACK

*Scope*

1. This method covers a procedure for determining the pellet size distribution of carbon black.

*Apparatus*

2. (*a*) *Mechanical Sieve-Shaker.*[1]
(*b*) *Standard Sieves,* or equivalents; of sizes Nos. 10, 18, 35, 60, and 120, having openings of 2000, 1000, 500, 250, and 125 microns, respectively. The sieves shall be 8 in. in diameter and 1 in. in height.
(*c*) *Sieve Cover.*
(*d*) *Bottom Receiver Pan.*
(*e*) *Riffle Sampler,* single stage.
(*f*) *Balance,* torsion or trip, having a sensitivity of 0.1 g.

*Procedure*

3. (*a*) Stack the sieves in the following order from bottom to top: bottom receiver pan, No. 120, No. 60, No. 35, No. 18 and No. 10 sieves, and top sieve cover.
(*b*) Prepare a sample of carbon black as follows:
(*1*) Pass the gross sample through the riffle sampler to obtain a test sample of 90 to 110 g. Repeat to obtain a second and third sample.
(*2*) Weigh each sample to the nearest 0.1 g.
(*c*) Transfer one of the weighed samples to the top sieve.
(*d*) Install the sieve cover and transfer the assembly to the mechanical sieve shaker.
(*e*) Allow the sieve assembly to shake for 1 min.[2]
(*f*) Remove the sieve assembly from the shaking device and weigh the carbon black retained on each sieve and bottom receiver pan individually to the nearest 0.1 g.
(*g*) Repeat the procedure for the other two test samples.

*Calculation and Report*

4. (*a*) Calculate the per cent pellet size distribution of the sample to the nearest 0.1 per cent as follows:

| Retained on Sieve | Pellet Size Distribution per cent |
|---|---|
| No. 10 | ——— |
| No. 18 | ——— |
| No. 35 | ——— |
| No. 60 | ——— |
| No. 120 | ——— |
| Receiver pan | ——— |
| | 100 |

(*b*) The report shall include the following:
(*1*) Proper identification of the sample,
(*2*) Proper identification of the test apparatus, and
(*3*) Average results obtained from the three individual determinations.

### SOLVENT-EXTRACTABLE MATERIAL IN CARBON BLACK

*Scope*

1. This method covers a procedure for determining the solvent-extractable material in carbon black.

*Apparatus*

2. (*a*) *Extraction Apparatus.*[3]
(*b*) *Thimbles,* to fit extraction tube; seamless and fat-extracted.
(*c*) *Electric Hot Plate,* with heater control.
(*d*) *Electric Oven,* capable of temperature regulation of ±1 C.
(*e*) *Analytical Balance,* having a sensitivity of 0.1 mg.
(*f*) *Solvent,* benzene, analytical grade, redistilled.[4]

*Procedure*

3. (*a*) Dry an extraction flask at 85 C for 1 hr.
(*b*) Cool in a desiccator to room temperature for 1 hr and weigh to the nearest 0.1 mg.
(*c*) Fill the tared thimble three fourths full of carbon black and weigh to the nearest 0.1 mg.
(*d*) Plug the open end of the thimble with glass wool or extracted cotton and place in the siphon cup.
(*e*) Add 50 to 75 ml of the solvent to the flask (see Section 4).
(*f*) Extract the specimen continuously for 16 hr, heating at a rate such that the time required to fill and empty the siphon cup will be between 2.5 and 3.5 min.
(*g*) Evaporate the solvent on a steam bath or hot plate. Remove the flask from the bath or hot plate just before the last trace of the benzene disappears.
(*h*) Dry the flask for 1 hr at a temperature of 85 C.
(*i*) Cool to room temperature in a desiccator and weigh to the nearest 0.1 mg.

*Precautions*

4. (*a*) Use necessary care in handling toxic and inflammable solvents such as benzene.
(*b*) Some solvents, notably acetone, may become polymerized in the presence of carbon black to give fictitiously high values.

*Calculation and Report*

5. (a) Calculate the per cent extractable material to the nearest 0.05 per cent as follows:

$$E = \frac{A - B}{C - D} \times 100$$

where:

$E$ = per cent extractable-material,
$A$ = weight in grams of extractable material and flask,
$B$ = weight in grams of flask,
$C$ = weight in grams of thimble and sample, and
$D$ = weight in grams of thimble.

(b) The report shall include the following:

(1) Proper identification of the sample, and

(2) Average results obtained from two individual determinations.

---

[1] The following mechanical sieve shakers are satisfactory for this purpose:
Ro-Tap sieve shaker (The W. S. Tyler Co.).
Laboratory Sifter Type HL (Great Western Manufacturing Co.).
Cenco-Meinzer sieve shaker (Central Scientific Co.).

[2] If the Ro-Tap sieve shaker is employed, the hammering device shall be in operation.

[3] The extraction apparatus shown in Fig. 1 of the Methods for Chemical Analysis of Rubber Products (ASTM Designation: D 297) is recommended. Carbon black may be weighed and folded into an extracted filter paper instead of being weighed into a tared thimble. An Alundum thimble of medium porosity, RA360, may be substituted for the siphon cup. The above procedure may be used with a larger sample, using a larger Soxhlet apparatus.

[4] Other solvents may be used by agreement between the purchaser and the supplier.

*Scope*

1. This method covers a procedure for determining the water-wash sieve residue in regular untreated carbon black. It may not be applicable to oil-treated carbon black, because the oil would prevent proper wetting of the black by the water.

*Apparatus*

2. (*a*) *Sieve and Filtering Apparatus,* as shown in Figs. 1, 2, and 3.

(*b*) *Torsion Balance* having a sensitivity of 0.01 g.

(*c*) *Analytical Balance* having a sensitivity of 0.1 mg.

(*d*) *Drying Oven.*

(*e*) *Standard sieves* of either phosphor-bronze or stainless steel. Table I shows the sieves which are generally used in this test. The sieve to be used shall be agreed upon by the purchaser and the supplier.

(*f*) *Weighing Dish,* tared.

*Procedure*

3. (*a*) Prior to making a test, clean the filter by opening valves *a* and *b* and closing valve *c* as shown in Fig. 1. Allow the filter to wash for 2 min.

(*b*) Close valve *b* and open valve *c*. With valves *a* and *c* completely open, regulate the water pressure by means of a reducing valve. The recommended water pressure is in the range of 20 to 50 psi.

(*c*) After the water pressure has been regulated, attach a sieve of the proper sieve number to the funnel and allow the water to run through it for 3 min. Stop the water flow by closing valves *a* and *c*. Examine the sieve for particles: if none is observed, the apparatus is ready for use (see Section 4).

(*d*) Weigh a 100-g sample of the carbon black on the torsion balance.

(*e*) Attach the proper sieve to the funnel and start the water flow by opening valves *a* and *c*.

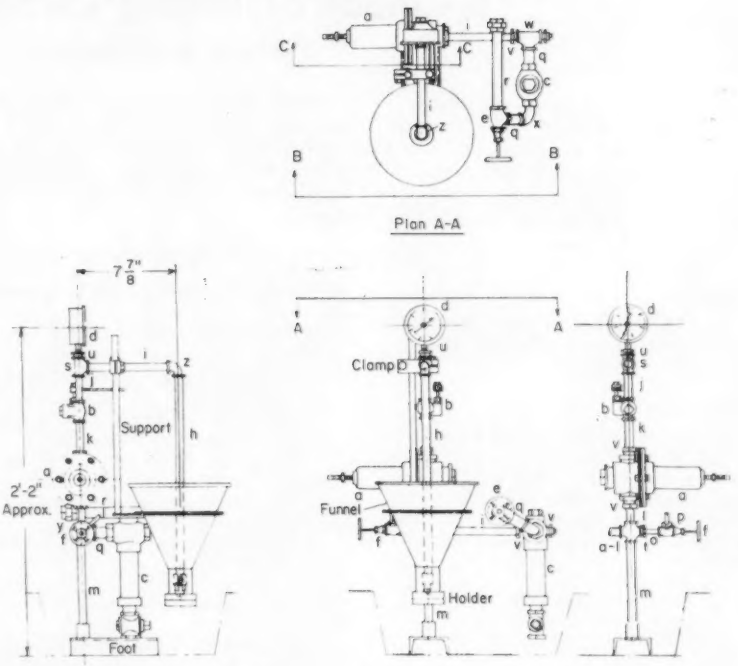
(*f*) Add the black slowly to the funnel to prevent plugging of the sieve.

(*g*) Use a gentle stream of water from the hose attached to valve *d* to wash down any black on the sides of the funnel.

(*h*) Continue washing until the wash water coming through the sieve is clear (Note 1).

(*i*) Remove the sieve from the funnel and rub the residue lightly with the finger to disaggregate any hard carbon black lumps which may not have been thoroughly wet by the water.

(*j*) Replace the sieve and wash for an additional 2 min.




*a*—½-in. reducing valve, bronze body, Fisher Type 75, 125 lb inlet, 15 lb outlet.
*b*—⅜-in. gate valve, bronze body, lever operated, Powell Fig. 362 "Petrol" type.
*c*—½-in. strainer, self cleaning, brass body, Spraco type with 200-mesh cylinder.
*d*—2½-in. dial pressure gage, Ashcroft type 100 g, brass case.
*e*—½-in. screwed brass angle valve, Crane No. 1205.
*f*—½-in. screwed brass angle valve.
*g*—Spray nozzle, female, brass, Spraco No. 5B.
*h*—⅜ by 16-in. standard weight brass pipe nipple.
*i*—⅜ by 7-in. standard weight brass pipe nipple.
*j*—⅜ by 2½-in. standard weight brass pipe nipple.
*k*—⅜ by 3-in. standard weight brass pipe nipple.
*l*—⅜ by 2-in. standard weight brass pipe nipple.
*m*—¾ by 7-in. standard weight brass pipe nipple, one end plugged.
*o*—⅛ by 1½-in. standard weight brass pipe nipple.
*p*—⅛ by 1½-in. standard weight brass pipe nipple, one end plain.
*q*—½ by 2-in. standard weight brass pipe nipple.
*r*—½ by 7-in. standard weight brass pipe nipple.
*s*—¾-in. standard brass screwed tee.
*t*—⅜ by ⅛-in. standard brass outside hexagon bushing.
*u*—⅜ by ¼-in. standard brass outside hexagon bushing.
*v*—½ by ⅜-in. standard brass outside hexagon bushing.
*w*—½-in. standard brass screwed tee, one end plugged.
*x*—½ in. standard brass 90-deg street ell.
*y*—½-in. brass 150-lb G. J. union, Crane Co. No. 521½.
*z*—¾-in. standard brass screwed 90-deg ell.
*a-1*—¾-in. standard brass screwed cross.

FIG. 1.—Sieve Residue Apparatus.

(*k*) Remove the sieve and dry for 1 hr at 105 C.

(*l*) Transfer the residue to the tared weighing dish and weigh (Note 2).

TABLE I.—SIEVES GENERALLY USED FOR RESIDUE TEST

| Standard Sieves | Microns | Sieve Opening, in. | Wire Diameter, in. | |
|---|---|---|---|---|
| | | | min | max |
| No. 30..... | 590 | 0.0232 | 0.0114 | 0.0165 |
| No. 80..... | 177 | 0.0070 | 0.0045 | 0.0061 |
| No. 200..... | 74 | 0.0029 | 0.0018 | 0.0024 |
| No. 325..... | 44 | 0.0017 | 0.0012 | 0.0016 |

NOTE 1.—If desired, a high-speed stirring apparatus may be used to disperse the black in water. It is also permissible to utilize wetting agents to facilitate dispersion. Care must be taken in the transfer of all materials from the vessel used for dispersing the black into the funnel of the washing apparatus.

NOTE 2.—To determine if all of the carbon black has been washed from the residue on the sieve, the dried residue may be transferred to a piece of white paper and rubbed gently. Any residual carbon on the inorganic residual or carbonaceous hard particles will smear the paper.

*Precautions*

4. (*a*) It is imperative that the apparatus be kept clean at all times to prevent contamination.

(*b*) Examine the sieves each time they are used to make sure that no cracks or holes develop.

(*c*) Examine the strainer periodically to ascertain if the filter sieve is in good condition.

*Calculation and Report*

5. (a) Calculate the per cent sieve residue as follows:

$$R = \frac{W}{S}$$

where:

$R$ = per cent sieve residue,
$W$ = weight in grams of sieve residue, and
$S$ = weight in grams of sample.

(b) The report shall include the following:

(1) Proper identification of the sample, and

(2) Average results obtained from two individual determinations.

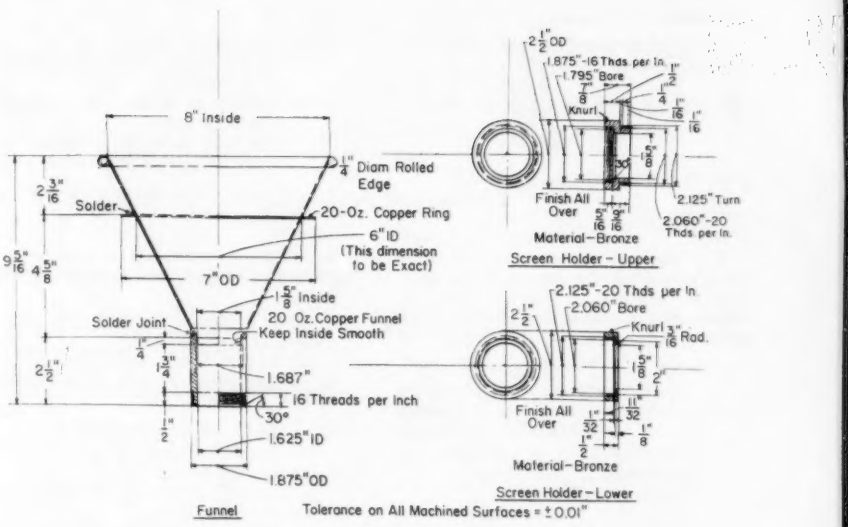



FIG. 2.—Funnel and Sieve Holder.

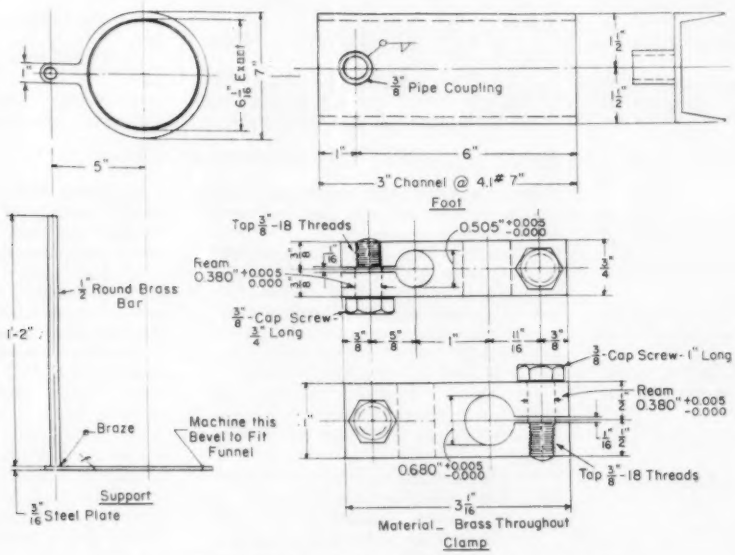



FIG. 3.—Clamp, Foot, and Support of Sieve Residue Apparatus.

## ATTRITION OF PELLETED CARBON BLACK

*Scope*

1. This method covers a procedure for determining the mechanical stability of pelleted carbon black.

*Apparatus*

2. (*a*) *Mechanical Sieve Shaker.*[5]

(*b*) *Standard Sieve* No. 100 (149-micron), or equivalent, 8 in. in diameter and 1 in. in height conforming to the specifications for Sieves for Testing Purposes (ASTM Designation: E 11).[5a]

(*c*) *Sieve Cover.*

(*d*) *Bottom Receiver Pan.*

(*e*) *Riffle Sampler*, single stage.

(*f*) *Balance*, torsion or trip, having a sensitivity of 0.1 g.

*Procedure*

3. (*a*) Adjust the sieve platform of the mechanical sieve shaker to accommodate one sieve receiver and cover.

(*b*) Prepare the sample of carbon black as follows:

(*1*) Pass the gross sample through the riffle sampler to obtain a test sample of 22 to 28 g. Repeat to obtain a second and third sample.

(*2*) Weigh each sample to the nearest 0.1 g.

(*c*) Transfer one of the weighed samples to the sieve.

(*d*) Complete the assembly, with the cover in place, and transfer to the mechanical sieve shaker.

(*e*) Allow the sieve assembly to shake for 20 min with the hammer operating.

(*f*) Remove the sieve assembly from the shaking device and weigh the carbon black retained in the receiver to the nearest 0.1 g.

(*g*) Repeat the procedure for the other two test samples.

[5] A Ro-Tap sieve shaker is satisfactory for this purpose.

[5a] 1955 Book of ASTM Standards, Parts 4 to 7.

*Calculation and Report*

4. (*a*) Calculate the per cent attrition as follows:

$$A = \frac{W}{S} \times 100 - F$$

where:

$A$ = per cent attrition,
$W$ = weight in grams of carbon black in receiver,
$S$ = weight in grams of original sample, and
$F$ = per cent fines as obtained in the Suggested Method of Test for Amount of Fines in Pelleted Carbon Black.[6]

(*b*) The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from the three individual determinations.

## DEGREE OF DISCOLORATION OF BENZENE BY CARBON BLACK

*Scope*

1. This method covers a procedure for determining the degree of discoloration of benzene by carbon black, by means of a photoelectric colorimeter or spectrophotometer.

*Apparatus*

2. (*a*) *Photoelectric Colorimeter or Spectrophotometer*, capable of measuring transmission in the 415 to 435 mμ range.

(*b*) *Absorption Cells* for colorimeter or spectrophotometer.

(*c*) *Electric Hot Plate.*

(*d*) *Erlenmeyer Flasks*, small size to hold the sample and solvent.

(*e*) *Benzene*, analytical grade.

(*f*) *Test Tubes*, to collect the filtrate.

(*g*) *Glass Filtering Funnels.*

(*h*) *Filter Paper*, soft.

(*i*) *Analytical Balance*, having a sensitivity of 0.1 mg.

(*j*) *Oven*, gravity convection type, capable of temperature regulation of ±1 C at 105 C.

*Procedure*

3. (*a*) Standardize the colorimeter or spectrophotometer (see Section 4) as follows:

(*1*) Fill the absorption cell with boiled, filtered benzene.

(*2*) Adjust the transmission value to 100 per cent, using a wave length of 415 to 435 mμ.

(*b*) Prepare the extract as follows:

(*1*) Dry an adequate sample of carbon black for 1 hr at 105 C.

(*2*) Transfer 3 to 5 g of the black to the Erlenmeyer flask.

(*3*) Add 10 ml of solvent for each gram of carbon black. The sample weight and solvent volume are determined by the volume of the absorption cell.

(*4*) Keep the mixture at a rolling boil for 20 sec.

(*5*) Filter immediately through the soft filter paper into a test tube; fill the absorption cell with the filtrate.

(*c*) Determine the per cent transmittance at 415 to 435 mμ.

*Precautions*

4. (*a*) Clean the absorption cells with lens tissue.

(*b*) Allow the colorimeter or spectrophotometer to warm up for at least 10 min before standardization.

(*c*) Rinse the absorption cell with clean solvent after each determination.

(*d*) If several absorption cells are used, they should be checked for differences in transmission between cells.

(*e*) For accurate results, the line voltage should be constant.

*Report*

5. The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from two individual determinations.

## IODINE NUMBER OF CARBON BLACK

*Scope*

1. This procedure covers a method for determining the iodine adsorption of carbon black.

*Apparatus*

2. (*a*) *Iodine Flasks*, heat-resistant,[7] with glass stoppers, having a capacity of 125 ml.

(*b*) *Volumetric Flasks*, 1-liter capacity.

(*c*) *Burets*, two of each required as follows:

(*1*) 50-ml capacity, graduated in 0.1 ml.

(*2*) 5-ml capacity, graduated in 0.01 ml.

(*d*) *Pipets*, 20-ml. capacity.

(*e*) *Buret Supports.*

(*f*) *Pipet Rack.*

(*g*) *Aspirator Bottles*, 2-liter capacity.

(*h*) *Bottles*, glass stoppered, as follows:

(*1*) 1-liter capacity.

(*2*) 2-liter capacity.

(*i*) *Analytical Balance*, having a sensitivity of 0.1 mg.

(*j*) *Beakers*, 50-ml capacity.

(*k*) *Erlenmeyer Flasks*, 250-ml capacity.

(*l*) *Oven*, gravity convection type, capable of temperature regulation of ±1 C at 105 C.

*Reagents*

3. (*a*) *Iodine Solution (0.473 N).*—Dissolve 60 g of cp iodine and 570 g of cp potassium iodide in 300 ml of distilled water in a 1-liter volumetric flask. Dilute to 1000 ml with distilled water after solution is complete.

(*b*) *Sodium Thiosulfate Solution (0.394 N).*—Dissolve 9.781 g of cp sodium thiosulfate bentahydrate, $Na_2S_2O_3 \cdot 5H_2O$,[8] in approximately 500 ml of distilled water, in a 1-liter volumetric flask. Add approximately 2 ml of *n*-amyl alcohol and dilute to 1000 ml with distilled water.

(*c*) *Starch Solution.* Dissolve approximately 2.5 g of starch and 5 mg of mercuric iodide in 1 liter of distilled water.

(*d*) *Standardization Solutions.*—One of the following standards is required:

(*1*) *Arsenite Solution (0.1 N)* for standardization of the iodine solution. Dissolve 4.9465 g of pure sublimed arsenic trioxide in 20 ml of a solution containing 4 g of cp sodium hydroxide. Do not heat the solution above 60 C. Add 200 ml. of a solution containing 10 g of sodium bicarbonate. Dilute to 1 liter with distilled water.

(*2*) *Potassium Dichromate Solution, (0.1 N)*, for standardization of sodium thiosulfate solution. Dissolve 4.9035 g of potassium dichromate in 1 liter of distilled water.

*Procedure*

4. (*a*) Dry an adequate sample of the carbon black for 1 hr at 105 C.

(*b*) Weigh 1.000 g of the black and transfer to the iodine flask.

(*c*) Add 5.00 ml of the iodine solution to the sample of black in the flask. Stopper the flask and let the mixture stand untouched for 40 min.[9]

(*d*) Add 45 ml of distilled water from a buret to the flask (see Section 5).

(*e*) Stopper and shake the mixture in the flask for 1 min.

(*f*) Allow the sample in the flask to settle for 1 hr.[10]

(*g*) Decant the supernatant iodine solution into a 50-ml beaker.

(*h*) Immediately after decanting the iodine solution into the beaker, pipet 20 ml into an Erlenmeyer flask.

(*i*) Titrate the iodine solution with the sodium thiosulfate solution until a pale yellow color remains. Add approximately 5 ml of the starch solution and continue titrating until one drop of sodium thiosulfate solution causes the blue color to change to colorless.

(*j*) Run a blank determination by following the procedure in Paragraphs (*c*) to (*i*).

*Precautions*

5. (*a*) Do not allow any of the distilled water to contact the "ground" surface when adding the water to the iodine carbon black mixture.

(*b*) All of the carbon black must be

[6] See p. 5.

[7] Pyrex glass is satisfactory for this purpose.

[8] If the anhydrous sodium thiosulfate is used, an equivalent normality is prepared.

[9] Silicone stopcock grease may be used on ground-glass stoppers to insure a tight seal of the stopper and to prevent freezing of the stopper.

[10] A centrifuge may be employed in this step if desired.

thoroughly wet by the iodine when adding iodine to the surface of the black.

(*c*) Unagitated, unpelletized carbon black must be densified before weighing.

*Calculation and Report*

6. (*a*) Calculate the iodine number, in milligrams of iodine per gram of carbon black, as follows:

$$I = \frac{B - S}{B} \times 5 \times N \times 126.91$$

where:

$I$ = iodine number in milligrams of iodine per gram of carbon black,
$B$ = blank titration value in milliliters of sodium thiosulfate solution,
$S$ = titration value of sample in milliliters of sodium thiosulfate, and
$N$ = normality of the iodine solution.

(*b*) The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from two individual determinations.

## AMOUNT OF FINES IN PELLETED CARBON BLACK

*Scope*

1. This method covers a procedure for determining the fines content of pelleted carbon black.

*Apparatus*

2. (*a*) *Mechanical Sieve-Shaker.*[5]

(*b*) *Standard Sieves.*—Three No. 100 (149-micron) sieves, or equivalent, and three sieves of any other size.[11] The sieves shall be 8 in. in diameter and 1 in. in height.

(*c*) *Sieve Separator Receivers,* five required.

(*d*) *Sieve Cover.*

(*e*) *Bottom Receiver Pan.*

(*f*) *Riffle Sampler,* single stage.

(*g*) *Balance,* torsion or trip, having a sensitivity of 0.1 g.

*Procedure*

3. (*a*) Stack the sieves in the following order from bottom to top: bottom receiver, separator-receiver and No. 100 sieve, alternately positioned, with cover on top sieve.

(*b*) Prepare samples of carbon black as follows:

(*1*) Pass the gross sample through the riffle sampler to obtain a test sample of 22 to 28 g. Repeat to obtain a second and third sample.

(*2*) Weigh each sample to the nearest 0.1 g.

(*c*) Transfer a weighed sample to each of the three bottom No. 100 sieves.[12]

(*d*) Complete the assembly, with the cover in place, and transfer to the mechanical sieve shaker.

(*e*) Allow the sieve assembly to shake for 1-min with the hammer operating.

(*f*) Remove the sieve assembly from the shaking device and weigh the carbon black retained on each receiver to the nearest 0.1 g.

*Calculation and Report*

4. (*a*) Calculate the per cent fines content to the nearest 0.1 per cent as follows:

$$F = \frac{W}{S} \times 100$$

where:

$F$ = percentage fines,
$W$ = weight in grams of carbon black in receiver,
$S$ = weight in grams of original sample.

(*b*) The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from the three individual determinations.

## HEATING LOSS OF CARBON BLACK

*Scope*

1. This method covers a procedure for determining the heating loss of carbon black at 105 C. This heating loss consists primarily of moisture, but traces of other volatile materials may also be lost. This method is not applicable to treated carbon black which contain added volatile materials.

*Apparatus*

2. (*a*) *Oven,* gravity convection type, capable of temperature regulation of ±1 C at 105 C.

(*b*) *Weighing Bottle,* low-form, 30 mm in height, and 60 mm in diameter, equipped with a ground-glass stopper.[13]

(*c*) *Analytical Balance,* having a sensitivity of 0.1 mg.

(*d*) *Desiccator.*

*Procedure*

3. (*a*) Dry the weighing bottle and the stopper, with the stopper removed, in the oven at 105 ± 1 C for 30 min. Place the bottle and stopper in the desiccator and allow to cool to room temperature. Weigh the bottle with stopper to the nearest 0.1 mg.

(*b*) Weigh 2 g of carbon black into the weighing bottle to the nearest 0.1 mg (see Section 4).

(*c*) Place the weighing bottle, sample, and stopper in the oven for 1 hr at 105 ± 1 C with the stopper removed.[14]

(*d*) Replace the stopper and transfer the bottle and contents to the desiccator. Remove the stopper and allow to cool to room temperature. Replace the stopper on the weighing bottle and reweigh to the nearest 0.1 mg.

*Precautions*

4. (*a*) Take the samples of carbon black in a tightly stoppered glass bottle or friction-top can. Allow the closed container to reach room temperature before starting the test.

(*b*) Keep the stopper on the weighing bottle when transferring to and from the desiccator to prevent loss of carbon black due to air currents.

*Calculation and Report*

5. (*a*) Calculate the per cent heating loss as follows:

$$H = \frac{(B - C)}{(B - A)} \times 100$$

where:

$H$ = per cent heating loss,
$A$ = weight in grams of weighing bottle and stopper,
$B$ = weight in grams of weighing bottle, stopper, and sample before heating, and
$C$ = weight in grams of weighing bottle, stopper, and sample after heating.

(*b*) The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from two individual determinations.

## POUR DENSITY OF PELLETED CARBON BLACK

*Scope*

1. This method covers a procedure for determining the pour density of pelleted carbon black.

*Apparatus*

2. (*a*) *Cylindrical Container,* 624-ml capacity.[15] The shape of the container shall be cylindrical, with uniform height and no pouring lip or deformation of the container wall.

(*b*) *Straightedge or Spatula,* at least 6 in. in length.

(*c*) *Balance,* torsion or trip, having a sensitivity of 0.1 g.

*Procedure*

3. Pour the carbon black into the center of the tared container from a

[11] The top three sieves may be of any size, as the sieves are only used as spacers.

[12] For consistent results, only the three bottom sieves are recommended for this test.

[13] A Kimble (15166) cap-style weighing bottle is satisfactory.

[14] Nonrubber grade carbon blacks should be dried to constant weight.

[15] A satisfactory container can be made by pouring 624 ml of water at 20 C into a 1000-ml or 1200-ml stainless steel beaker 4 ft ± 1 ft 4 in. in diameter, and marking the water level. Then cut the beaker at this mark after chucking it firmly in a lathe.

height not more than 2 in. above the rim. A large enough excess should be used to form a cone above the rim of the cylinder. Level the surface with a single sweep of the straightedge or spatula held in a perpendicular position. Determine the weight of the carbon black to the nearest gram.

*Calculation and Report*

4. (*a*) Calculate the pour density as follows:

$$D = \frac{W}{10}$$

where:

$D$ = pour density in pounds per cubic foot, and

$W$ = weight of carbon black in grams.

(*b*) The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from two individual determinations.

## VOLATILE CONTENT OF CARBON BLACK

*Scope*

1. This method covers a procedure for determining the volatile materials other than moisture in carbon black.

NOTE.—This method is essentially the same as the procedure for determination of volatile matter described in Sections 13 and 14 of the Methods of Laboratory Sampling and Analysis of Coal and Coke (ASTM Designation: D 271).[16]

*Apparatus*

2. (*a*) *Electric Furnace*, capable of temperature regulation of ±25 C at 950 C,[17] equipped with a thermocouple-activated indicating pyrometer.

(*b*) *Platinum Crucible*, 20-ml capacity, equipped with insert form cover.

(*c*) *Interval Timer*, checked for accuracy.

(*d*) *Oven*, gravity convection type, capable of temperature regulation of ±1 C at 105 C.

(*e*) *Analytical Balance*, having a sensitivity of 0.1 mg.

(*f*) *Desiccator*.

*Procedure*

3. (*a*) Ignite the platinum crucible with cover in the electric furnace at 950 ±25 C for approximately ½ hr. The crucible shall be positioned in the electric furnace not more than ¼ in. from the thermocouple terminal. Place the crucible and cover in the desiccator. Cool to room temperature and weigh to the nearest 0.1 mg.

(*b*) Dry an adequate sample of carbon black for 1 hr at 105 C.

(*c*) Fill the platinum crucible with the dry carbon black to a level not more than 2 mm below the cover line. This is designed primarily for pelletized carbon blacks. Where the volatile content of unpelletized carbon black is desired, firmly tamp the black in the crucible to prevent oxidation. The small air space is necessary to allow for the expansion of the escaping volatile matter, thus preventing the raising of the cover and the possible oxidation of the black. The crucible cover should fit firmly in place, but should have sufficient clearance to permit the volatile matter to escape.

(*d*) Weigh the crucible, cover, and contents to the nearest 0.1 mg.

(*e*) Ignite the covered crucible and contents in the electric furnace for exactly 7 min at a temperature of 950 ± 25 C (see Section 4 (*b*) and (*c*)).

(*f*) Remove the crucible to the desiccator, allow to cool to room temperature, and weigh to the nearest 0.1 mg.

*Calculation and Report*

4. (*a*) Calculate the per cent volatile content as follows:

$$V = \frac{(B - C)}{(B - A)} \times 100$$

where:

$V$ = per cent volatile content,

$A$ = weight in grams of crucible and cover,

$B$ = weight in grams of crucible, cover, and sample before ignition, and

$C$ = weight in grams of crucible, cover, and sample after ignition.

(*b*) The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from two individual determinations.

## pH VALUE OF CARBON BLACK

*Scope*

1. This method covers a procedure for determining the pH value of carbon black.

*Apparatus*

2. (*a*) *pH Meter*, equipped with glass and calomel electrodes having an accuracy of ±0.05 pH and conforming to the requirements in the method for Determination of pH of Aqueous Solutions with the Glass Electrode (ASTM Designation: E 70).[5a]

(*b*) *Beakers and Watch Glasses*,[18] of sufficient size to accommodate the sample used.

(*c*) *Hot Plate*.

(*d*) *Spatula and Glass or Porcelain Plate, or Mortar and Pestle*.

(*e*) *Container*, stainless steel or copper, for boiling distilled water.

*Procedure*

3. (*a*) Crush any pelleted or lumpy carbon black to a fine powder, using either the spatula and plate or mortar and pestle.

(*b*) Add 10 ml of boiling distilled water to each gram of carbon black weighed into the glass beakers. To facilitate wetting of unpelletized black, add a few drops of pure ethanol or acetone.

(*c*) For large samples of 1 g or more of carbon black, boil the mixture for 15 min, but do not allow to go to dryness.

(*d*) For small samples of 0.1 to 0.5 g of carbon black, use 5-ml beakers and boil the mixture on the hot plate until a sludge remains, but do not allow to go to dryness.

(*e*) Let the mixture cool to room temperature in an atmosphere free from chemical fumes which might contaminate the samples. Decant off any supernatant liquid.

(*f*) Place the electrodes in the sludge and rotate the beaker gently in alternate directions until a constant pH value is obtained. Follow the procedure described in Method E 70.

*Precautions*

4. (*a*) To prevent contamination of the sample during boiling, a clean watch glass may be used over the beaker.

(*b*) Standardize the pH meter with a reliable buffer in the pH range of the carbon black samples to be tested.

(*c*) The distilled water used in the test should be as pure as possible. The pH of the freshly boiled distilled water shall be 6.9 to 7.1.

5. The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from two individual determinations.

## ASH CONTENT OF CARBON BLACK

*Scope*

1. This method covers a procedure for determining the ash content of carbon black.

*Apparatus*

2. (*a*) *Muffle Furnace*, capable of temperature regulation of ±25 C at 550 C.

(*b*) *Porcelain Crucible*, high-form, size 0, rim 35 mm, height 29 mm, capacity 15 ml, with cover size E.

(*c*) *Analytical Balance*, having a sensitivity of 0.1 mg.

(*d*) *Desiccator*.

(*e*) *Oven*, gravity convection type, capable of temperature regulation of ±1 C at 105 C.

*Procedure*

3. (*a*) Ignite the crucible with the cover in the muffle furnace at 550 ± 25

[16] 1955 Book of ASTM Standards, Part 5.

[17] A vertical electric-type furnace, such as the Hoskins type FA 120, or a standard muffle furnace, is satisfactory for this purpose.

[18] Pyrex or other high-silica glassware should be used to minimize contamination during boiling.

C for 1 hr. Place the crucible and cover in the desiccator. Cool to room temperature and weigh to nearest 0.1 mg.

(*b*) Dry an adequate sample of carbon black for 1 hr at 105 C.

(*c*) Weigh 2 g of the dried carbon black into the ignited crucible and place in the furnace at 550 C for 16 hr[19] with the cover removed (see Section 4). Replace the cover, remove to the desiccator, and allow to cool to room temperature. Weigh to the nearest 0.1 mg.

*Precautions*

4. (*a*) Keep the door of the furnace open about ¼ in. to admit air to support the combustion of organic material.

(*b*) Exert care in removing ashed sample from furnace to desiccator.

(*c*) Always keep the cover on the crucible when transferring it to and from the desiccator to prevent the loss of ash due to air currents.

(*d*) After the sample has cooled in the desiccator, admit air slowly to avoid loss of ash from the crucible.

*Calculation and Report*

5. (*a*) Calculate the per cent ash as follows:

$$A = \frac{(D - B)}{(C - B)} \times 100$$

where:

$A$ = per cent ash,
$B$ = weight in grams of crucible,
$C$ = weight in grams of crucible plus the sample, and
$D$ = weight in grams of crucible plus the ash.

(*b*) The report shall include the following:

(*1*) Proper identification of the sample, and

(*2*) Average results obtained from two individual determinations.

## MASS STRENGTH OF PELLETED CARBON BLACK

*Scope*

1. This method covers a procedure for determining the mass strength of pelleted carbon black. This method is designed to determine the mass strength of a cylindrical column of carbon black pellets.

*Apparatus*

2. (*a*) *Testing Machine*,[20] of construction and dimensions as shown in Fig 1. The tube shall be made from seamless stainless-steel tubing, and the plunger shall be made from cold-rolled stainless-steel shafting.

(*b*) *Cylindrical Weights*, of 15, 10, 5, and 2.5 lb each, with an accumulative weight of at least 50 lb. Each individual weight shall weigh to within ±1 oz of the assigned value.

(*c*) *Optional Equipment.*—Weight-lifting device as shown in Fig. 2.

*Procedure*

3. (*a*) Place the cylinder shown in Fig. 1 on a level surface.

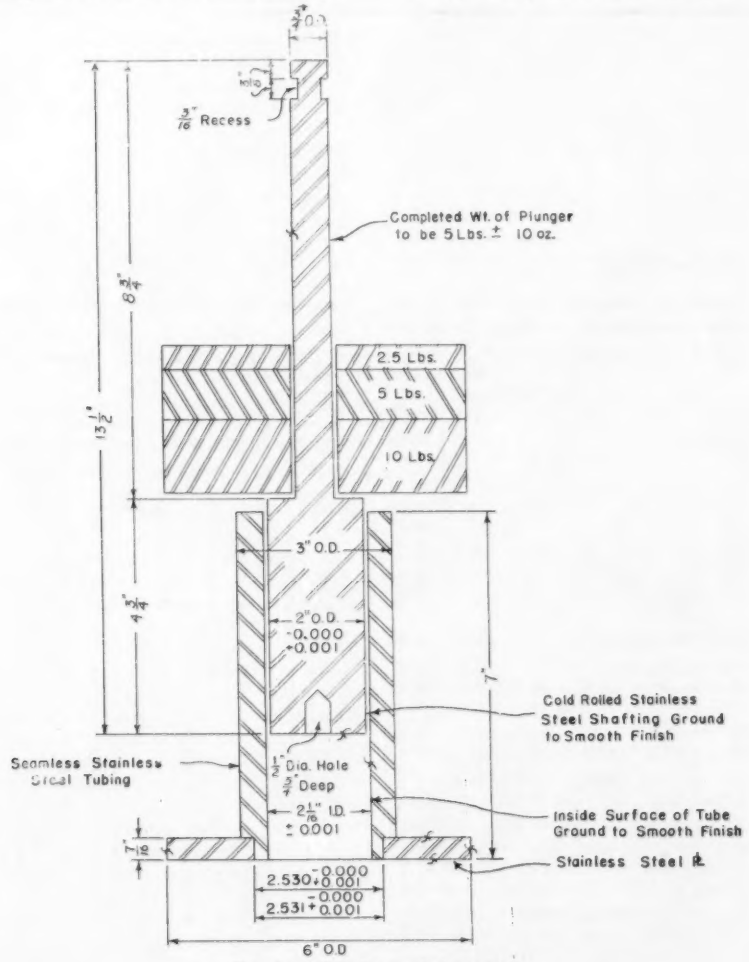

3/16" Recess
Completed Wt. of Plunger to be 5 Lbs. ± 10 oz.
2.5 Lbs.
5 Lbs.
10 Lbs.
3" O.D.
2" O.D. -0.000 +0.001
Cold Rolled Stainless Steel Shafting Ground to Smooth Finish
Seamless Stainless Steel Tubing
½" Dia. Hole ⅝" Deep
2 1/16" I.D. ± 0001
Inside Surface of Tube Ground to Smooth Finish
Stainless Steel
2.530 -0.000 +0.001
2.531 -0.000 +0.001
6" O.D.

FIG. 1.—Mass Strength Apparatus.

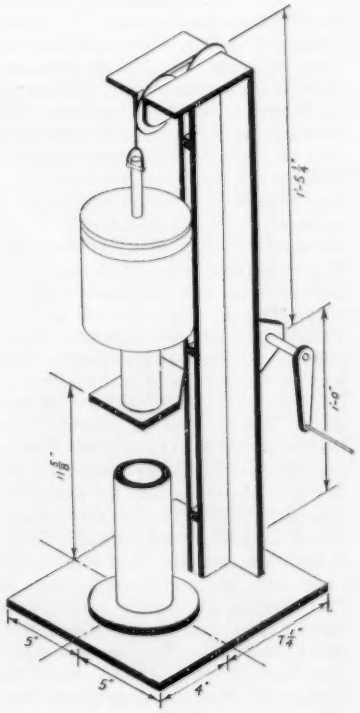


FIG. 2.—Mass Strength Weight-Lifting Apparatus.

[19] Since channel-process carbon blacks contain no volatile inorganic salts, it is permissible for control purposes to use an ashing temperature of 950 C usually requiring 4 to 5 hr.

[20] This machine and method was originated by the Western Electric Co. under U. S. Patent No. 2,633,027, and issued to N. R. Bunnell.

(*b*) Fill the cylinder with carbon black pellets to within approximately 1 in. of capacity, and then level the top surface with a spatula (see Section 4).

(*c*) Fit the plunger, with the initial weights in place, into the top of the cylinder and gently lower it onto the column of pellets. Allow the plunger and weight assembly to remain in this position for at least 10 sec.

(*d*) Remove the plunger and weight. Carefully raise the cylinder. If all of the pellets flow from the cylinder when the cylinder is lifted, repeat the test on a new sample by increasing the weight in increments of 2.5 lb. If any of the carbon-black pellets adhere to the inside cylinder wall, repeat the test on a new sample by reducing the weight in increments of 2.5 lb.

*Precautions*

4. (*a*) The top surface of the carbon black column must be leveled to prevent unequal pressure on the column.

(*b*) The plunger and weight assembly must be lowered and raised in a perpendicular manner to obtain uniform action on the column of carbon black. This is the purpose of the optional equipment shown in Fig. 2.

*Report*

5. Report the end point as the minimum weight in pounds required to produce ring formation of carbon-black pellets adhering to the cylinder wall.

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## Key West Corrosion Test Site Reclassified

THE Advisory Committee on Corrosion has changed the classification of its Key West, Fla., test site from "marine" to "rural (marine)" after an inspection of the data on rates of corrosion at this location. This classification is intended to indicate a mild atmosphere slightly contaminated with sea salt spray but free from industrial pollution. The test site has been relocated twice and probably is now in the least severe of the three locations. The data from the atmospheric corrosion test recently completed by Committee B-3 on the Corrosion of Non-Ferrous Metals, as organized below, indicate conditions at Key West to have been more comparable to State College, Pa., than to the other two marine locations. The ratios of the penetration at the three sites to that at State College indicate that the latter was more corrosive to about one-half the specimens than Key West. The time to perforation of black steel sheets at Sandy Hook, Kure Beach, and Key West is about the same and about one-sixth that at State College; the reverse is true of the time to first rust on galvanized steel sheets, where Key West appears milder than State College. In the case of the black steel sheets it is suspected that storm-driven sea spray contaminated the groundward side of the sheets or was trapped in the rust film and acted as an accelerant, whereas in the case of the other materials, the washing effect of the rains removed this excessive contamination.

RATIO OF PENETRATION AT KEY WEST, LA JOLLA, AND SANDY HOOK TO THAT AT STATE COLLEGE.

| Material | | Key West / State College | | La Jolla / State College | | Sandy Hook / State College | |
|---|---|---|---|---|---|---|---|
| | | 10 yr | 20 yr | 10 yr | 20 yr | 10 yr | 20 yr |
| F | 92Cu, 8Sn | 0.42 | 0.43 | 0.65 | 0.65 | 5.2 | 5.15 |
| M | 70Cu, 30Zn | 0.53 | 0.47 | 0.37 | 0.37 | 2.5 | ... |
| N | 70Cu, 29Zn, 1Sn | 0.91 | ... | 0.63 | 0.63 | 2.8 | ... |
| P | 75Cu, 20Ni, 5Zn | 0.5 | 0.5 | 0.85 | 0.85 | 2.9 | ... |
| Q | 70Cu, 29Ni, 1Sn | 0.57 | 0.57 | 0.7 | 0.7 | 3 | ... |
| S | 65Ni, 32Cu, 2Fe, 1Mn | 0.67 | 0.67 | 0.95 | 0.95 | 5.3 | ... |
| T | 99+Ni | 0.48 | 0.48 | 0.68 | 0.68 | 4.7 | ... |
| AA | 99Zn, 0.85Pb | 0.6 | 0.6 | 1.5 | 1.5 | 1.3 | ... |
| BB | 99.9Zn | 0.5 | 0.5 | 1.6 | 1.6 | 1.6 | 1.6 |
| HH | 99.9Zn | 0.42 | ... | 2.2 | 2.2 | 1.8 | 1.8 |
| Z | 98Al, 0.5Mg, 1Si | 1 | 1 | 11 | 11 | 5.5 | ... |
| A | 99.9Cu | 1.25 | 1.3 | 3 | 2.9 | 1.1 | ... |
| B | 99.9Cu, 0.007P | 1.4 | 1.4 | 4 | 4 | 1.27 | ... |
| L | 85Cu, 15Zn | 1.3 | 1.3 | 0.7 | 0.72 | 1.5 | ... |
| U | 99.92Pb, 0.06Cu | 1.15 | ... | 1.6 | 1.6 | 1.05 | ... |
| CC | 99Pb, 1Sb | 1.6 | ... | 1.6 | 1.65 | 1.45 | ... |
| C | 96Cu, 3Si, 1Mn | 2.1 | ... | 2.7 | 2.7 | 2.4 | ... |
| D | 92Cu, 8Sn | 2.2 | 2.2 | 7.0 | 7.2 | 3.7 | ... |
| I | 99Al, 1Mn | 3.6 | ... | 8.2 | 8.1 | 4.4 | 4.3 |
| G | 99Al | 3 | ... | 8.5 | 8.3 | 3.7 | 3.6 |
| K | 66Cu, 19Zn6Al5Fe4Mn | 4 | 4 | 4.0 | 4.1 | 9.3 | 9.2 |
| EE | 99.85Sn | 4.8 | ... | 5.2 | ... | 4 | ... |
| | Mean | 1.3 | ... | 3.1 | ... | 3.4 | ... |

TIME TO PERFORATION OR FIRST RUST, YR

| | State College | Key West | Sandy Hook | Kure Beach, 800-ft Lot |
|---|---|---|---|---|
| Black sheet, perforation | 26 | 3.6 | 5.9 | 13.5 |
| Galvanized sheet, first rust | 13 | 21.5 | 6.5 | 13.5 |

# The New ASTM Grain-Size Methods

By L. L. Wyman[1]

THE PROPOSAL for the Determination of Average Grain Size of Metallic Materials, E 112 – 55 T, appearing in Part 2 of the 1955 Book of ASTM Standards, represents the culmination of over 18 years of concentrated effort to correlate all grain-size determinative and comparison methods into one comprehensive "standard." This correlation represents a major accomplishment through the developmental stages of which many significant factors have been brought to light. It is the intent of Committee E-4 that the more salient points of this information be transmitted to the Society members through the medium of this presentation.

At present, there are four grain-size "methods" in the Society's Books of Standards, each of which had its inception in some particular branch of metallurgy, to which it was apparently considered to be quite peculiar. In addition, three more methods have been variously proposed by other special metal interests. Technically, however, this segregating is erroneous, for all of these methods do but one thing—evaluate the size of the "average grain" from the microstructure. As such, this evaluation is nothing more than a measurement of an area, a problem in geometry as it were. Moreover, the geometrical considerations involved are of a certainty, independent of the material being examined, thus the new uniform grain-size method, which is predicated primarily on the basic technical aspects, should adequately serve all suitable structures—be they metallic or even some nonmetallics.

"Average" grain sizes are customarily established either by counting methods or by comparison with standard charts. In the counting methods, the Planimetric (or Jeffries) Method (applicable to equiaxed grains), requires the count of the number of grains in a known area at a known magnification, and subsequently mathematically converts these values to the calculated average grain areas (assuming spherical grains) and thence to calculated average grain diameters. On the other hand, the Intercept (or Heyn Method), especially applicable to elongated grains, counts the number of grains intercepted by lines of known length, in three mutually perpendicular directions (longitudinal, transverse, and normal) to again arrive at a calculated grain size.

When the results of such counting methods are expressed and used in terms of "grains per square millimeter" or other equivalent expressions, the numerical results have an obvious significance. However, when these results are further mathematically transformed into terms such as "0.025-mm grain diameter," it must be fully realized that this value represents a *calculated diameter* of an "average" grain—the latter hypothetical unit being an average of all areas of grains intercepted by the plane of polish, in and cut by the counting circle.

One other factor concerning these counting methods should be emphasized, particularly when considered in the light of more recent work where volumetric considerations are of importance. This, of course, involves the derivation of three-dimensional space-filling values from the two dimensional microstructure, and at this point the "chance-section" effect must be employed for the solution of the problem.

Briefly, the situation is this: common sense, empirical experimentation, or mathematics will show that a plane section cut through a volume which is filled with uniformly sized cells will coincide with but few, if any, equatorial planes of these cells (true diameter). In fact, experimentation and calculation mutually corroborate at a value of about 0.78 for the relation. From this there are two factors which should always be kept in mind:

1. The actual areas on the photomicrographs are *not* equatorial planes of the grains—they are smaller.

2. A correction factor must be applied in order to arrive at true dimensions.

While the above-mentioned correction factor is applicable to a chance section through a volume filled with various sizes of "equiaxed" units, this condition does not prevail for nonequiaxed units wherein two different problems exist, that is (1) the "drawn-out" grains which, while they may present an "equiaxed" cross-section amenable to a planimetric count, have a length which should be subjected to the intercept method, and (2) the "rolled-out" grains which become thinner and wider as they become longer—thus necessitating intercept analyses. Moreover, it must be realized that, in these latter structures, correction factors will vary with different ratios of length : breadth : thickness.

These are the principles which dictate the preferable referee methods for the two general types of structures.

Turning next to consideration of the comparison method of estimating grain size, one may state that the name is self-explanatory of the method and leaves naught to add. This, however, would be a masterful understatement, for there are a number of inobvious factors which have an appreciable bearing on the effective use of the method.

In the first place, one must have the comparison standard. And just what are the requirements for this standard?

It must be (*a*) accurate, (*b*) realistic, and (*c*) usable.

By analyzing the appearances of the prepared microsections of our many metals and alloys with respect to grain peculiarities in size, shape, angularity, twinning, contrast of etching, etc., it is found that there are three primary categories that can be used to classify all these materials, and which are realistic.

These categories are:

(*a*) Untwinned grains, flat etch
(*b*) Twinned grains, flat etch
(*c*) Twinned grains, contrast etch

to which, for special applications, must be added

(*d*) Austenite in carburized steel (McQuaid-Ehn, etc.)

These then represent the structure types in the four grain-size comparison charts which will be issued with the new method, uniformly printed in black and white.

In effect, these represent the types of structures shown in the comparison standards of

(*a*) E 89 and E 91 (in part),
(*b*) E 19 and E 91 (in part),
(*c*) E 79 and E 91 (in part), and
(*d*) E 19, respectively.

The new comparison standards, which are photomicrographs of superb quality, are shown in the several plates at the same magnifications as those at which comparable types of structure were dis-

[1] Chairman, Committee E-4 and Chief, Chemical Metallurgy Section, Metallurgy Div., National Bureau of Standards, Washington, D.C.

played in the older methods. The magnifications used, 75 × and 100 ×, originally derive from the design of microscope optics, coupled with a convenience which would permit the display of all of the useful sizes at the same magnification—which is in itself a compromise.

Ideally, the use of but one basic magnification would be excellent. However, one is forced to recognize the existence of numerous specifications, laboratory equipment, and trained laboratory personnel—all geared to the present magnifications. Thus the practicality of a uniform magnification becomes lost in the contemplated magnitude of the cost of such a change. Furthermore, with our presently increased interest in, and the demand for, more accurate determinations of grain size, even the protrayal of an entire series at these conventional magnifications becomes inadequate as subsequent discussion will disclose.

It may be well to emphasize particularly the fact that the grain sizes shown in the new comparison charts are of an unusually high degree of accuracy. In fact, the actual grain counts on these areas are within a per cent or so of the theoretical mean or actual values rated on the charts in the smallest and most difficultly countable sizes, and are in exact agreement for the intermediate and larger sizes of grains.

This is quite in contrast to some of the older charts where, for example in E 19, the actual grain counts on some of the micrographs were sufficiently in error from the mean so that any attempt to interpolate could easily result in an evaluation which would be one ASTM grain size in error. Consequently, in initiating the use of the new charts, metallurgists should carefully check their desired (or specified) grain sizes against the new standards in order to be sure that accurate grain sizes are being quoted.

Another source of difficulty with the older comparison charts concerns the number of grains included in the micrographs and the sizes of the micrographs. For example, on examining the old charts one finds that at the large-grained end of the series there are actually too few grains included to hope to have any reasonable statistical accuracy in counting. Consequently, the new charts of the structures coarser than ASTM No. 3 are shown in a circle of twice the normal size and thus include more grains for counting.

When one considers these factors together with the recommendations concerning the minimum numbers of grains to be counted, then even the enlargements incorporated in the new charts may prove to be inadequate. In such instances the magnifications may be increased (or decreased) in simple multiples and the "counts" referred to the conversion table which will give the results at 75 × or 100 ×.

Rather than insist on statistically acceptable sampling on grain areas—and thereby create such horrendous counting problems that no metal could be approved—certain reasonable minimum acceptabilities needed to be established. Specifically, these consist of the requirement that at least three areas "considered to be representative" shall be counted, and that there must be at least 50 grains in an area. Furthermore, for greater accuracy, areas having 500 to 1000 grains should be used.

While it has been rather naively presumed that all of the old micrographs were of 79.8-mm diameter (corresponding to a 5000-sq mm Jeffries circle), such has not been the case, and many of the areas are appreciably divergent from this value and have led to fictitious grain counts. Furthermore, the masking of the micrograph to the desired area presents significant difficulties in the actual counting of the half-grains around the periphery of a Jeffries circle. Thus in order to overcome both of the abovementioned difficulties, the new micrographs of ASTM grain sizes of No. 3 and finer are predicated on a 90-mm diameter exposed area of photomicrograph on which a 79.8-mm circle has been accurately scribed, thus permitting the operator more readily to evaluate the whole area and more easily judge whether a grain is "in" or "out" of the circle, or if a grain boundary is hidden by the counting circle.

Earlier, mention was made of realism and usability with reference to the companion standards; and while there may appear to be different criteria, they are quite intimately related because sad experiences have shown that (*a*) if the standards are not realistic they will not be used and (*b*) if they do not reasonably well resemble the "unknown" then operator errors are prone to occur. For example, truly accurate hexagonal networks were at one time adopted for comparison standards—and withdrawn in favor of simulated micrographs a few years later because of the nonacceptance of the networks—they were not realistic. Also, many of the so-called "operator-errors" were ably demonstrated by the exhaustive long-time tests so ably conducted and analyzed by Committee B-5.

Another factor of importance is also related to the human elements involved, in that tests have also revealed that more uniform and consistent results can be obtained when the standards and the unknown are projected adjacently on a screen at comparable light intensities than can be obtained by comparing the unknown on the microscope screen with a wall chart of the standards.

The recommended use of co-projection of the standards and the sample in question immediately involves the availability of suitable transparencies for viewing the standards. This subject is now being reviewed, and it is planned to have such transparencies available from Society Headquarters.

The use of the comparison charts and sometimes even counting methods may involve other difficulties which, at present, may be typed as operator or instrument errors of real significance. Specifically, these were derivations brought to light in a "round-robin" of grain-size samples conducted by committee B-5 and again in an E-4–B-5 task group, wherein the reports from some of the laboratories revealed a definite "bias" over a portion of the grain size ranges. For example, one laboratory might be "low" on the large grain sizes and satisfactory on all others, or another might be satisfactory on the large and intermediate sizes, and "high" on the small sizes.

Whether these are due to human traits of the operators or due to faulty magnifications is presently unknown. That such conditions can prevail is a matter of record, and, recognizing such to be the case, it might be well for all laboratories to have a check system in periodic operation in order to insure the accuracy of their grain size determinations.

The manner in which the results of grain-size determinations are expressed may vary, one industry or one plant having become accustomed to the use of terms involving the numbers of grains per unit area or unit of volume, while another has concentrated on calculated average grain diameters in inches or in millimeters. This lack of uniform nomenclature, coupled with the obvious advisability of having a systematic logarithmic relationship between the grain sizes shown on the reference charts, gave rise to the ASTM grain-size system.

When such a system was put to practical use, grain sizes were sometimes intermediate between whole-numbered steps; in other instances the desired specified product grain size, or the control grain size at a given fabricating stage, occurred at an intermediate step. These factors have given legitimate cause for the inclusion of the half-sizes which are in the series.

It would, of course, be preferable to have but one grain-size term for all metallurgists. Such cannot be legislated, but it is hoped that by suggestion and recommendation "whenever the

ASTM grain-size number is not quoted as the initial designation, it be subsequently added in parentheses" will eventually achieve the preferred results. Certainly this situation is analogous to the Fahrenheit-Centigrade temperature scale reference situation constantly facing us. However it provides a much better solution to the transition problem in that there is provided a common reference.

Due to unfortunate circumstances, several photomicrographs still remain to be added to Plate III, and Plate II needs completion. As soon as this has been accomplished, these comparison standards and text will be discussed with the technical committees concerned with their use, the ultimate objective being the replacement of all four of the older methods by E 112 when referenced in the Society's specifications.

This attainment of a uniform system of grain size determination has been a goal of Committee E-4 for many years. To cite individually those workers who have labored in this work would provide too long a roster to give such credit here and might involve some embarrassing omissions. Likewise, to adequately extol those who have borne the brunt of this effort, most particularly in the preparation and checking of standard micrographs, would merit a separate paper. However, all those who worked so long and diligently may rest assured that their service is not "unheralded."[2]

[2] ASTM Bulletin No. 207, July, 1955.

# Notes on Compression Testing of Metals

## Comprises a Technical Memorandum (No. 2) of the Column Research Council

It is desirable to have compressive stress-strain curves of material from as many different sources as possible, together with the usual identifying tensile properties obtained from specimens adjacent to specimens used for determining the compressive stress-strain curves. In order that the compression specimens and the tension specimens be as nearly as possible equally representative of the material, the cross-sections of compressive specimens in general should be the same as those of the adjacent tension specimens.

Specimens taken from a flange with parallel faces or from the web of a rolled shape or from a plate should be rectangular in cross-section. They should be machined only on the two cut sides and on the ends. In a thin specimen, however, which requires lateral support to prevent premature buckling it is permissible to remove just enough material from the supported faces of the specimen, if necessary, to make them plane.

The ends of compression specimens should be plane and normal to the longitudinal axis of the specimen. The ends should be parallel within close limits. In most cases this requirement necessitates the turning or grinding of the ends.

In general, compression specimens should be no longer than necessary to accommodate a compressometer or strain gages and leave between each end of the specimen and the adjacent end of the gage length a length of specimen equal to the greatest cross-sectional dimension. The compressometer should meet specifications for ASTM class A extensometers,[1] which limit the error in indicated strain to $\pm 0.00001$ in. per in. In order to obtain a representative stress-strain curve, the gage length should be not less than the greatest cross-sectional dimension; and in order to keep the specimen short, the gage length should not exceed twice this dimension. If the length of a rectangular specimen is more than about 4.5 times the length of the shorter side of the rectangle or of a circular specimen more than 4 times the diameter, difficulty may be expected in avoiding premature bending (column action), and special precautions must be taken to prevent excessive bending.[2] Referring to Fig. 1, the following relationships summarize the above requirements for a member of rectangular cross-section:

$$G \leqq b$$
$$G \geqq t$$
$$4.5t \leqq L \leqq G + 2b$$

where:

$G$ = gage length,
$b$ = width of specimen,
$L$ = length of specimen, and
$t$ = thickness of specimen.

The dimensions of each test specimen should be given. The specimens should be measured with a micrometer reading to 0.001 in. Nominal dimensions should not be used.

Both ends of a compression specimen should bear on smoothly finished plane surfaces. The bearing blocks should be made of or faced with suitably hard material such that the faces of the blocks will not suffer permanent deformation during the test. The blocks should be at least as thick as the smallest cross-sectional dimension of the specimen and should project beyond the area of contact a distance at least half as great as the smallest cross-sectional dimension.

Precautions should be taken to insure uniform distribution of strain over the cross-section and to prevent relative rotation of upper and lower surfaces throughout the test. The following are suggested methods: (1) Capping with a thin layer of plaster of Paris between the upper bearing block and the head of the testing machine. While the plaster is setting, a load should be maintained that will bring those machine surfaces into contact that will normally be in contact at higher loads; (2) use of a subpress loaded through a push rod acting at the lower end of a hollow plunger, and (3) use of bearing blocks which will permit adjustment for parallelism of bearing surfaces.[3] The deviation in strain of one gage from the average of all gages at 50 per cent of the estimated yield strength of the material should be no more than $\pm 5$ per cent.

Adjustable bearing blocks cannot be depended upon to compensate for tilting of the heads of the testing machine during loading of the specimen and should be used only if appreciable relative tilting of the heads does not occur. If a spherical bearing block is used, it should be at the upper end of the specimen (for specimens tested with the axis vertical). It is desirable that the center of the spherical surface lie in the flat

[1] 1956 Book of ASTM Standards, Part 6.
[2] For rectangular specimens see ASTM Method of Compression Testing of Metallic Materials in Sheet Form: (E 78 – 49 T).
[3] See Fig. 2 in ASTM Methods of Compression Testing of Metallic Materials in Other than Sheet Form: (E 9 – 49 T).

face which bears on the specimen. It is important that the center of the spherical surface be placed close to the axis of the specimen, so that the eccentricity of loading may not be great enough to overcome the friction necessary to rotate the block.

If the length of the specimen does not exceed the maximum recommended length (4.5 or 4 times a cross-sectional dimension for a rectangular or a circular specimen, respectively), strains should be measured with an averaging compressometer or with two strain gages mounted opposite each other. In the case of longer specimens tested without lateral support, reasonable certainty of uniform distribution of strain can be obtained only with the use of not fewer than two strain gages on the wide sides of a rectangular specimen, four gages on a square specimen, or three on a circular specimen. Strains measured on only one gage length are usually unsatisfactory. The stress-strain curve should extend from zero stress and strain to values for which the ratio of stress to strain is at least as low as $0.7E$ or to a strain of at least 0.01 in. per in., whichever results in the larger strain.

Since the properties of the material are a function of the rate of loading, if the loading is continuous, the rate of loading should be recorded. Compressive stress-strain curves should be plotted with stress as ordinate and strain as abscissa to as large a scale as the accuracy of the data justifies. The individual values of stress and strain should also be reported. When applying the above procedures to material which is suspected of showing a considerable variation in properties, the specimens should be taken from a sufficient number of locations to define the extent of the variation in properties.

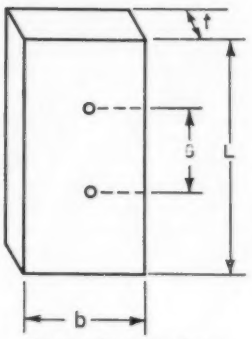

Fig. 1.—Test Specimen.

*Determination of Typical Stress-strain Curve from a Number of Individual Stress-strain Curves:*

It is assumed that the compressive stress-strain relationships of enough specimens will be determined so that all variations of the material likely to be submitted under a given specification will be represented. The yield strength values determined from the individual tests should be presented in the form of a distribution plot in which the per cent of the total number of tests for which the yield strength is within a certain range is plotted against the average value of the range.

Several different methods can be used for obtaining a typical stress-strain curve from a number of individual stress-strain curves. One method which is fairly simple and has had considerable use is described generally as follows:

1. Record the strain departures from the modulus line for various fixed percentages of the particular individual yield strength value. These percentages should cover stresses from the proportional limit to above the yield strength.
2. Average all offset values for each of the fixed percentages. (For steel beams it is recommended that the offsets be weighted in proportion to relative flange and web areas.) A curve may then be plotted in which the ordinate is the per cent of yield strength and the abscissa is the strain offset from the initial modulus line.
3. For any appropriate yield strength value, a typical stress-strain curve can then be plotted by adding the offset values to the strain consistent with the elastic modulus value.

Figure 2 shows a typical compression stress-strain curve of a high-strength aluminum alloy. Lines have been drawn tangent to this curve at different values of stress $P/A$. The slopes of these lines define the corresponding tangent, modulus, $E_t$,[4] essential to the determination of the basic column strength.[5]

[4] Convenient and accurate techniques are available for determining the tangent modulus; one such technique is described in NACA TN 2640, "Interaction of Column and Local Buckling in Compression Members," by P. P. Bijlaard and G. P. Fisher.

[5] See "The Basic Column Formula," Technical Memorandum No. 1, Column Research Council, May, 1952.

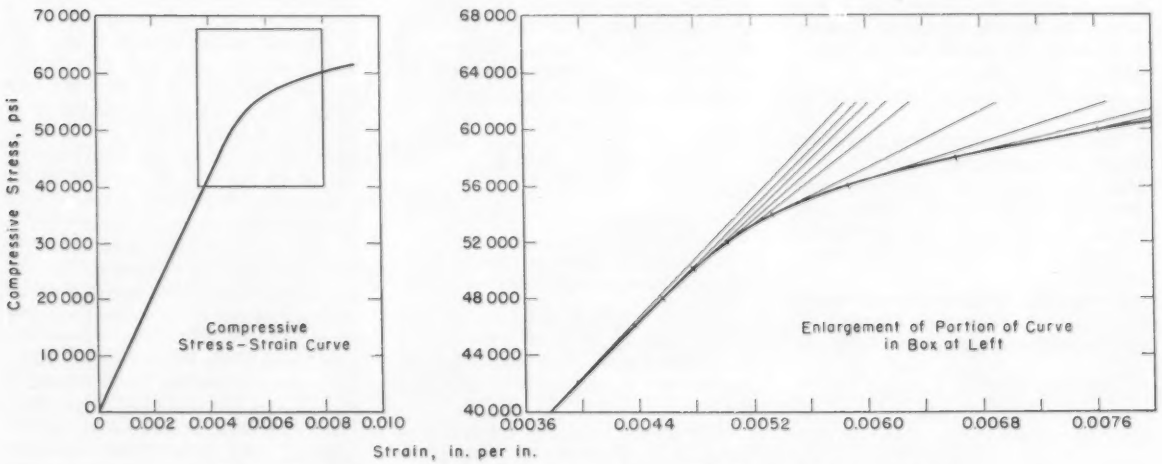

Fig. 2.—Typical Compression Stress-Strain Curve of a High-Strength Aluminum Alloy.

# Proposed Method of Test for Water Vapor Transmission of Building Materials Utilizing the Penn State-Armstrong Cell

**The measurement of water vapor transmission of building materials has been receiving greater attention in the industry. ASTM Committee C-16 on Thermal Insulating Materials has undertaken to establish standards in this field in order to obtain values for use in design, manufacturing, and marketing of building materials. The method described is based on the Model 3, Penn State-Armstrong Cell. This cell was described by F. A. Joy and E. R. Queer in Penn State University Engineering Experiment Station *Technical Paper No. 46*, "Permeance Measurement Improved by Special Cell," and by F. A. Joy, E. R. Queer, R. E. Schreiner, in the Penn State University Engineering Experiment Station, *Bulletin 61*, "Water Vapor Transfer Through Building Materials." The primary purpose of this method is to provide a reliable procedure for determining the water vapor permeance of a thick specimen of homogeneous material or composite of two or more materials and is being published now for information only.**

**Comments are solicited and should be addressed to the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.**

### Scope

1. This method will provide an accurate measurement of the water vapor transmission[1] (WVT) of specimens of insulating and related materials, including protective coatings, either singularly or in combination with one another. The apparatus will accommodate both thin and thick specimens equally well, but is particularly useful for very thick specimens. Since the weight of the sample does not enter into the measurements certain limitations of the dish method are overcome. An additional advantage is that relative humidity control of the ambient air is not required.

### Definitions

2. *Perm.*—A unit for permeance expressed in grains per hr × sq ft × inches of mercury.

### Significance of Test

3. Correlation of test values by this method with any given use must be determined by experience.

### Apparatus

4. (*a*) *Cell Chambers* of the Penn State-Armstrong WVT Cell, Fig. 1, shall be made of noncorroding material, impermeable to water vapor.[2] The chambers may be square or round, cast or prefabricated. The mouth opening of the chambers shall be at least 100 sq in. A flange or ledge around the mouth is required to provide for proper seating of the specimen holding ring. The cell chambers shall contain weighing mechanisms for determining water evaporation and desiccant gain and facilities for determining the vapor pressure on each side of the specimen.

(*b*) *Specimen Holding Ring* shall be made of noncorroding material impermeable to water vapor. The ring shall be of metal or a high compressive strength plastic so that it will with-

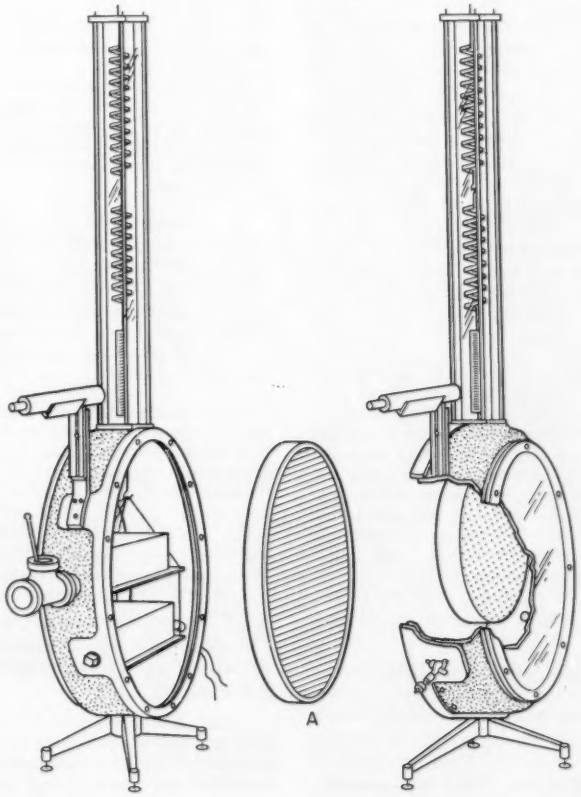


**Fig. 1.—Water Vapor Transmission Cell, Model 3, by Pennsylvania State University—Armstrong Cork Co.**

*A*—Test specimen mounted in holding ring.

[1] The definitions of rate of water vapor transmission, water vapor permeance, and water vapor permeability as used in this paper are those given in the tentative revision of the Standard Definitions of Terms Relating to Thermal Insulating Materials (C 168–51), 1955 Book of ASTM Standards, Part 3.

[2] For information regarding the construction or procurement of the Model 3 cell, contact the Department of Engineering Research (E. R. Queer, Director) of the Pennsylvania State University at University Park, Pa.

stand the stress applied when clamped tightly between the cell chambers. The ring may be of any wall thickness. The outside diameter of the ring is fixed by the diameter of the flanges or ledges on the cell chambers. The ring width should be governed by the thickness of the test specimen so as to reduce the thickness of the air layer between the specimen surfaces and the point of vapor pressure measurement. A free ring width of ¼ in. on each side of the test specimen is recommended.

(*c*) *Weighing Mechanism* for determining water evaporation and desiccant gain shall be contained either within the cell chamber proper or enclosed in a housing connected to the cell chamber and forming an integral part of the cell chamber. The weighing mechanism may consist of calibrated springs with a suitable method for determining the change in spring deflection with change in weight of water and desiccant containers. The deflection of the coil springs supporting the water and desiccant containers is determined either by sighting a fixed microscope on a graduated scale forming a part of the spring-to-container linkage or by a differential transformer in which the core of the transformer is a part of the spring-to-container linkage. The weighing mechanism must be sensitive and accurate. The sensitivity and accuracy shall not be poorer than 2 per cent of the weight change during the period when a steady state is considered to exist. An accuracy of ¼ grain has been obtained utilizing a coil spring with a constant of 1000 grains per in. deflection and measuring deflection with a linear variable transformer.

*Example.*—A one perm specimen of 100 sq in. area at 70 F with 95 per cent relative humidity on one surface and 0 per cent on the other surface passes 11.7 grains per day. In 17 days of steady state the transfer is 198 grains. For this usage the mechanism must have a sensitivity and accuracy of 2 per cent of 198 grains or 4 grains. If, however, the mechanism has a sensitivity and accuracy of 1 grain, the required steady state period could be reduced to 4 days and conversely a ¼ perm specimen would require only 17 days of steady state transfer.

(*d*) *Vapor Pressure Measurement Apparatus* may consist of either an electric hygrometer installed within the cell chambers or by dew point measuring apparatus within or closely coupled to the cell chambers. The vapor pressure prevailing within the cell chambers shall be determined periodically during a test. The point of measurement should be as close to the surfaces of the specimens as possible so as to reduce the thickness of the air layer between the point of measurement and the specimen surfaces.

(*e*) *Vapor Source* should be a saturated solution of potassium nitrate ($KNO_3$). This will provide a relative humidity of approximately 95 per cent and guard against loss of moisture due to condensation on the chamber surfaces due to small temperature fluctuations in the ambient air. Other salt solutions may be sustituted if a lower relative humidity is desired. The exposed solution should be at least 20 sq in. When the solution area is less than the specimen area the vapor pressure may be expected to vary with specimen permeance, decreasing with increased permeance. Ordinarily this would be objectionable, however, it does not affect the test in this case as the vapor pressure prevailing in the chamber is measured.

(*f*) *Desiccant Sink.*—The vapor sink shall be calcium chloride in the form of small lumps that will pass a No. 8 sieve and free of fines that will pass a No. 30 sieve (see Note). It shall be dried at 400 F by the testing agency before use. The quantity of desiccant to be used is determined by the capacity of the weighing mechanism and the quantity required to limit the moisture pickup during a test to 6 per cent of its weight.

NOTE.—If calcium chloride will react on the specimen an adsorbing desiccant such as silica gel, activated at 400 F may be used but the moisture gain by this desiccant during the test must be limited to 2 per cent.

(*g*) *Sealant* used in attaching the specimen to the ring shall be highly resistant to the passage of water vapor (and water). It shall not lose weight to, or gain weight from the atmosphere in an amount, over the required period of time, that would affect the test result by more than 2 per cent.

NOTE.—Recommended sealants are shown in the Appendix of ASTM Tentative Method of Test for Water Vapor Transmission of Materials Used in Building Construction (C 355–54 T).

(*h*) *Test Cell* shall be operated within a constant temperature room or cabinet. The temperature shall be chosen between 70 and 90 F and maintained constant to ±1 F, 90 F is recommended (see Note). The temperature shall be measured frequently or preferably recorded continuously.

NOTE.—Simple temperature control by heating alone is made possible at 90 F. However, it is very desirable to enter the controlled space and a comfortable temperature is more satisfactory for that arrangement. 73.4 F (23 C) and 80 F have been found satisfactory.

### Test Specimen

5. Specimens shall be representative of the material tested. When the material is in sheet or ready-to-use form and may be used with either face toward the vapor source, at least four specimens shall be tested by the same method. The sides may be designated *A* and *B* and at least two specimens shall be tested with side *A* toward the vapor source and two with side *B* toward the vapor source. When the material is designed for use in one position only, at least three specimens shall be tested with the vapor flow in the designed direction. Specimens shall be cut to fit the holding ring with allowances for a film of sealant on the edges.

### Sealing of Specimen into Holding Ring

6. For specimens other than thin sheets the edges of the specimen shall be completely sealed with a suitable sealant. The specimen with the edge sealed is then placed in the ring and secured to the ring with the sealant. The specimen may be clamped if necessary to prevent warpage and rupture of the seal. In applying sealant to seal the specimen to the ring, care should be taken to limit the overlap of sealant of the specimen faces to a minimum and to provide essentially the same overlap on each surface of the specimen. The effective diameter of the specimen is the mean of the original diameter and the diameter of the unsealed surface of the specimen.

### Procedure

7. (*a*) Seal the test specimen in the holding ring according to Section 6.

(*b*) Place the salt solution and desiccant containers in their respective cell chambers taking care that the containers hang freely on the weighing mechanism.

(*c*) Place a film of sealant either on the specimen ring or on the cell chamber ledges or flanges and draw the cell chambers together to clamp firmly the specimen ring.

(*d*) Level the cell assembly and check the position of the desiccant and water containers to make sure that they hang freely and do not touch the cell chamber wall or the specimen surface.

(*e*) Obtain an initial reading of water and desiccant weight as soon as feasible. These readings may be helpful in an understanding of the initial moisture in the specimen.

(*f*) Make determinations of weight change of water, weight gain of desiccant and vapor pressure in each cell chamber periodically, plotting results as provided in Section 8.

(*g*) Terminate the test or change the desiccant before the water added to the desiccant exceeds 6 per cent of its starting weight.

NOTE.—Some specimens may be advantageously preconditioned to minimize

the moisture that the specimen will give up to the desiccant. This applies when the specimen is likely to have high moisture content or when it is coated on the vapor source side.

### Plotting and Calculation

8. (*a*) Make weight change determinations frequently enough to provide eight or more determinations during the test.

(*b*) Plot the loss in weight of water and gain in weight of desiccant against elapsed time on the same chart. Inscribe curves which tend to become straight and parallel. Judgment here is required and numerous points are helpful. When straight lines fit the plots of water loss and desiccant gain and are parallel (or approach parallelism) over a span of four or more properly spaced points (with due allowance for sensitivity of weighing) a nominally steady state exists. The rate of vapor transmission is the slope of either line if parallelism exists or the average slope of the two lines if they only approach parallelism.

NOTE.—For thick hydroscopic specimens of low permeability, the time required to reach the steady state will be long. Other materials may reach it quickly.

(*c*) Make determinations of the vapor pressure in each chamber frequently enough to provide three or more determinations during the portion of the test when steady state transfer is considered to exist. The determined values should be averaged to define the vapor pressure existing in each chamber.

(*d*) Calculate the water vapor transmission (WVT) and permeance[2] from the following equations:

$$\text{WVT} = \frac{G}{tA} = \frac{G/t}{A} \quad \ldots\ldots (1)$$

where:

- $G$ = weight change in grains of the sample (from the straight line),
- $t$ = time in hours during which $G$ occurred,
- $G/t$ = the slope of the straight line in grains per hr,
- $A$ = test area in sq ft, and
- WVT = water vapor transmission in grains per sq ft-hr.

$$\text{Permeance, } P_1 = \frac{\text{WVT}}{v_1 - v_2} = \frac{\text{WVT}}{\Delta v} \quad \ldots (2)$$

where:

- $\Delta v$ = vapor pressure difference between wet and dry chamber in inches of mercury,
- $v_1$ = vapor pressure in the wet chamber, and
- $v_2$ = vapor pressure in the dry chamber.

The permeance determined by the above formula may be only an approximation for highly permeant specimens since the air layer between the plane of vapor pressure measurement and the specimen surface may be a significant portion of the over-all resistance. A correction for the effect of this air layer may be applied to the permeance value calculated by Eq 2. A procedure for correcting for the air layer is as follows:

(*1*) Determine the approximate thickness of the layer between the vertical plane of vapor pressure measurement and the surface of the specimen in each chamber of the cell. Combine these thicknesses to obtain the total thickness of air layer.

(*2*) Calculate the permeance of the total thickness of the air layer utilizing a reasonable value for permeability of air. A value may be determined by an appropriate test or may be obtained from the literature. A permeance value of 94 perms for 2.75 in. wide vertical air space is available.[3] This value will give a permeability for air of 260 perms per in.

$$\text{Permeance of air layer, } p_2 = \frac{\text{Permeability of air}}{\text{Thickness of air layer}}$$

(*3*) Correct the permeance calculated from Eq 2 by the following equation:

$$\frac{1}{p_2} = \frac{1}{p_1} - \frac{1}{p_2} \quad \ldots\ldots (3)$$

where:

- $p_2$ = corrected permeance,
- $p_1$ = permeance calculated from Eq 2, and
- $p_2$ = permeance of the air layer.

*Example.*—Assume 3 in. air layer and a permeance value of 10.0 obtained from Eq 2, then:

Permeance of air layer, $p_2 = 260/3 = 87$ perms, and, $1/p_2 = (1/10.0), -(1/87) = 0.100 - 0.011 = 0.089$, $p_2 = 1/0.089 = 11.2$ perms, is the corrected permeance.

### Report

9. The report shall include:

(*1*) The identification of the material tested, including its thickness,
(*2*) The test temperature,
(*3*) The vapor pressure in each test chamber,
(*4*) The permeance of each specimen in perms (to two significant figures),
(*5*) The side of each specimen on which the high vapor pressure was applied. The sides shall be distinguished as: side *A* and side *B*, when there is no obvious difference between them. When there is an obvious difference, this difference shall also be stated, such as: side *A* waxed and side *B* unwaxed, and
(*6*) The average permeance of all specimens tested in each position.

[2] F. A. Joy, E. R. Queer, and R. E. Schreiner, "Water Vapor Transfer Through Building Materials," Engineering Experiment Station, *Bulletin 61*, The Pennsylvania State University, Table 8, p. 60.

## Academy's Materials Advisory Board to Survey Defense Materials Research

AT THE special request of the Department of Defense, the Materials Advisory Board of the National Academy of Sciences–National Research Council, has begun a study of the technical content and organization of the materials research program of the Department. A special advisory committee is responsible for the study and for the development of such recommendations as may be deemed necessary. J. R. Townsend, chairman of the Materials Advisory Board, is serving as chairman and Francis C. Frary, vice-chairman of the Board, is vice-chairman of the committee. The following Academy members are serving on the committee:

E. C. Bain, U. S. Steel Corp.
E. K. Bolton, formerly with E. I. du Pont de Nemours and Co.
John Chipman, Massachusetts Inst. of Technology
Paul D. Foote, formerly with Gulf Research and Development Co.
Zay Jeffries, formerly with General Electric Co.
C. K. Leith, University of Wisconsin
Carl S. Marvel, University of Illinois

Fourteen technical panels have been established under the special committee to make the detailed surveys necessary in specific fields. The panels and their chairmen are as follows:

*High Temperature*—A. J. Herzig, Climax Molybdenum Co. of Michigan
*Ferrous*—E. C. Smith, Republic Steel Corp.
*Non-ferrous (excepting titanium)*—A. J. Phillips, American Smelting and Refining Co.
*Titanium*—F. C. Frary, consultant with Aluminum Co. of America
*Magnetic*—Richard M. Bozorth, Bell Telephone Laboratories
*Semiconductors*—L. W. Apker, General Electric Co.
*Miscellaneous*—Walter C. Voss, Consultant for Architectural Construction and Materials
*Deterioration and Prevention*—F. L. LaQue, International Nickel Co.
*Plastics*—Gordon Kline, National Bureau of Standards
*Elastomers*—R. F. Dunbrook, Firestone Tire and Rubber Co.
*Textiles*—W. J. Hamburger, Fabric Research Laboratories, Inc.
*Dielectrics*—D. A. McLean, Bell Telephone Laboratories
*Adhesives*—L. J. Markwardt, Forest Products Laboratory
*Ceramics and Refractories*—Hans Thurnauer, Minnesota Mining and Manufacturing Co.

# Random Samples...

## FROM THE CURRENT MATERIALS NEWS

*From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream, or address Random Samples, ASTM, 1916 Race St., Philadelphia 3, Pa.*

### *Two New "Super" Alloys for the Aircraft Industry*

Two new high-temperature alloys for aircraft and industrial gas turbine applications have been announced by the International Nickel Co.

The first, Inconel "700"* age-hardenable nickel-cobalt-chromium alloy, contains approximately 50 per cent nickel and 30 per cent cobalt. This new alloy, a modification of Inco's Inconel "X"* high-temperature alloy, was developed by Inco for aircraft designers who were seeking adequate strength for forged aircraft gas turbine blades at temperatures up to 1650 F. A metal was required that could be operated at a working temperature approximately 150 F higher than the Inconel "X" alloy.

This nickel-cobalt-chromium alloy is now produced as hot-rolled rounds in the size range of $\frac{5}{8}$ to 2 in. diameters; all rods are furnished with a turned or ground finish. A small amount of cold-rolled sheet has been produced experimentally. The mechanical properties of the Inconel "700" alloy at 1650 F are very similar to those of Inconel "X" at 1500 F. The new alloy has enabled aircraft engine builders either to increase the performance of the current engines or to plan the designing of future engines to operate at a higher temperature range.

The second new product, Incoloy "901"* nickel-iron-chromium alloy, has been developed for use in aircraft and industrial gas turbines for those components requiring high creep and rupture strength in the temperature range of 1000 to 1400 F. At these temperatures, the Incoloy "901" alloy has properties that compare favorably with those of the "super" alloys, yet is low in strategic alloy content.

An important physical property of this new alloy is its low coefficient of thermal expansion. Containing approximately 40 per cent nickel, it is close enough to ferritic alloy steels to permit the two materials to be joined without special provision for thermal expansion. In addition to bar and forging stock, the alloy is also produced as sheet in the same sizes and gages as those offered in Inconel "X" and Inconel "W"* age-hardenable alloys. Incoloy "901" is expected to find wide application for use in turbine rotor and compressor disks and structural parts calling for an intermediate temperature range of 1000 to 1400 F.

The two alloys were developed by Inco research which was conducted both at Huntington, W. Va., and Bayonne, N. J.

* Trademark—The International Nickel Co., Inc.

### *New Moon*

THE upper atmosphere has now become a laboratory for the physical chemist. High-altitude rockets introduce experimental materials into the "chemosphere"—the region above about 50 miles up—where strong ultraviolet radiation from the sun keeps atmospheric gases ionized, or dissociated, and where consequently, many chemical reactions proceed under conditions hard to duplicate on the surface of the earth.

It has been known for some time that, at high altitudes, intense ultraviolet radiation will split a molecule of oxygen into its two constituent oxygen atoms, each bearing an electrical charge. At lower altitudes the effect is not detectable, since most ultraviolet light is screened out by a thin layer of ozone just below the chemosphere. Scientists at the Air Force Cambridge Research Center duplicated the conditions of the chemosphere in the laboratory and discovered that if nitric oxide gas were added, the oxygen atoms would combine into molecules. The nitric oxide actually takes no major part in the reaction, but serves as a catalyst, or stimulator. Energy, in the form of light, is emitted during the reaction. The process occurs naturally in the chemosphere, but the normal concentration of nitric oxide is so low that the resulting radiation can only be detected at night, with the aid of sensitive instruments.

In March of this year, an Aerobee rocket, equipped to release nitric oxide gas under high pressure, was sent up to an altitude of 60 miles. When the gas was discharged, ground observers saw an illuminated region, which in ten minutes had enlarged to about four times the apparent diameter of the moon, and seemed to shine half as brightly. The spreading gas produced an effective reaction area estimated at three miles in diameter; after a short time, the nitric oxide had diffused so widely that the light could no longer be detected without instruments.

In a preliminary experiment, an Aerobee carried nitric oxide aloft in the daytime. Any illumination that might have been produced was masked out by the sunlight, but scanning by radar revealed a wide region of ionization, or electrification, that reflected radar waves just as the naturally occurring atmosphere (an electrically charged region beginning about 30 miles above the earth) reflects radio waves. An obvious implication is that we may eventually be able to create and sustain areas of artificial ionosphere to serve as reflectors for long-distance radio communication. That could only be done in the daytime, however, since the ion cloud is thought to be produced by the action of sunlight on the nitric oxide.

Atomic sodium is another constituent of the upper atmosphere. It is present only in small traces, but the yellow light characteristic of sodium is prominent in the spectrum of both twilight- and night-sky illumination—the so-called "air glow"—and in the aurora. Again the light seems to be produced by what is essentially a chemical reaction. But the much denser atmosphere at lower altitudes makes it impossible to determine, from the ground, the exact altitude of emission, the intensity of the light, the nature of the light-producing reaction, and, perhaps most interesting of all, how the sodium got up there in the first place.

In several high-altitude rocket launchings, metallic sodium has been sprayed into the chemosphere during twilight; illuminated clouds were observed as far as 300 miles away from the firing range. The character of the clouds changed with altitude—below about 50 miles they were white, but above that they were orange, indicating the emission of light characteristic of sodium. So far, no good reason for the difference has been found.

Additional experiments in the Air Force's program will deal with other materials that may participate in known or suspected high-altitude chemical reactions. Further probing of the chemosphere may eventually suggest ways to harness the energy present for space flight; meanwhile, considerable basic research must be done before we can understand this strange region in any detail.

—*Industrial Bulletin*, Arthur D. Little Co. Inc., May, 1956.

### *Shades of Alchemy*

MAN-MADE industrial diamonds are now being produced in limited quantities at the Detroit pilot plant of General Electric's Carboloy Department, it was revealed recently. This announcement was part of the ceremonies marking the presentation to the Smithsonian Institution of a cluster of General Electric's first man-made diamonds.

"Since 1954, when the first diamonds were made in the G-E Research Laboratory in Schenectady, we have been making steady progress in bridging the gap between the first experiments and the production line," J. S. Gillespie, manager of Carboloy's diamond project stated.

He pointed out that the two main areas of concentrations are the production of man-made diamonds in quantity, and at a marketable price. While progress is being made on both these problems, Gillespie stressed that there is "still more to be accomplished before we will have industrial diamonds commercially available."

The supply of industrial diamonds is essential to U. S. industry. In an emergency, it is possible that the source of natural stones, South Africa, could be cut off, and, if this happened, many key industrial processes would be greatly handicapped. A domestic source of man-made diamonds, identical in every way to natural industrial diamonds, would help make this nation independent of the natural source.

The industrial diamond business is estimated as having a $200 million dollar potential within the next decade—if the cost of man-made diamonds can be brought down below those now being mined. Much of this potential is caused by the increasing demand for high production of interchangeable parts which must be held to very close tolerances. Diamonds are used for finishing these parts and for shaping and dressing grinding wheels that produce these tolerances.

"Commercial diamonds are now being consumed at the rate of 12 million carats a year. This represents a $50 million dollar business," Gillespie said, "with about 80 per cent of these, by weight, going into grinding wheels, the balance in rock drills, wheel dressers, metal cutting tools and dies."

### *Railroad Research Points the Way*

BOLTS have been found to be superior to rivets in some railroad structures. The fatigue strength of alloy steels is somewhat higher than that of carbon steel plates. Synthetic paints are far superior to the red lead paints on surfaces subjected to brine drippings.

These were some of the observations made by E. J. Ruble, head of steel, concrete, and timber structure research at the Association of American Railroads, at the sixth lecture in a mechanics colloquium series at Illinois Institute of Technology, Chicago, on April 18.

Ruble said it previously had been the contention of railroad bridge engineers that bolts capable of developing a high clamping action would not stay tight when subjected to dynamic loads. This was based, he pointed out, on the fact that in many locations on railroad structures it had been impossible to keep rivets tight.

To test the capabilities of bolts, the AAR research staff arranged with the railroads to install about 2000 high-strength bolts in 15 different bridges. Some of these bolts, Ruble said, were installed in locations where considerable trouble had been encountered in keeping rivets tight, such as lateral bracings, diaphragms between beams, stringer connections, floorbeam connections, and floorbeam hangers. "The bolts have now stayed tight about eight years and have proved satisfactory," he pointed out.

Tests conducted on plain plates, or even plates with a hole, have indicated that the fatigue strength of the alloy steels is somewhat higher than that of carbon steel plates, although the increase in fatigue strength does not increase in proportion to the increase in yield strength of the alloy steels, Ruble said. The tests on the various alloy steels when fabricated into joints and fastened with rivets have indicated that there is little difference in the fatigue strengths. However, if the joints were fastened with high-strength bolts, the fatigue strength of the alloy steels is considerably higher than that of carbon steel joints.

Other investigations conducted by the Research Council on Riveted and Bolted Structural Joints have shown that the fatigue strength of structural joints fastened with cold driven rivets is considerably lower than those fastened with hot driven rivets.

Reporting on work done with different types of paint, Ruble pointed out that losses due to corrosion from brine drippings on railroad tracks and bridges amount to about $70,000,000 per year.

### *Titanium, Riding on Air*

MAJOR orders for titanium bolts received by Standard Pressed Steel Co. from two leading aircraft makers and approval of SPS titanium fasteners by a third company and by the Navy indicate that the titanium bandwagon is finally picking up steam in the aviation industry.

The Jenkintown, Pa., precision fastener company reports that the Glenn L. Martin Co. has ordered $200,000 worth of its Hi-Ti fasteners for use on the Navy's new SeaMaster jet bomber and that Chance Vought Aircraft, Inc., has also ordered a sizable quantity of the titanium bolts for the Navy's supersonic jet fighter, the Crusader.

At the same time, SPS revealed that it had just been approved as a source for high-strength titanium shear bolts by Boeing Airplane Co. and that the Navy Bureau of Aeronautics had just completed satisfactory laboratory tests of Standard's Hi-Ti titanium tension and shear bolts.

These developments follow a $650,000 order for titanium bolts for an Air Force plane received late last year by SPS from the Convair Division of General Dynamics Corp.

Chance Vought's F8U1 Crusader, unofficially said to have reached speeds in excess of 1000 miles per hour in flight, is billed as the world's fastest Navy jet fighter. Martin's XP6M-1 SeaMaster is the world's first multijet sea-based bomber.

The titanium fasteners, which weigh 43 per cent less than the steel bolts they replace, will permit significant weight reductions on both the Crusader and the SeaMaster.

During most of last year, when leading airplane makers and Government agencies such as Wright Air Development Center were running evaluation

tests of the new fasteners, SPS produced titanium bolts only in qualification lots. Output was measured in pounds. This year, SPS production is being measured in tons.

### Tektites

The origin of tektites—jewel-like glass bits that have been found scattered in many places over the earth's surface—is still unknown. These small pieces of meteoric glass, usually ranging in weight from a fraction of an ounce to more than a pound, have unique chemical and physical properties; they are unlike other types of meteorites, any igneous rocks, or artificially produced glass. Tektites are found both in irregular and symmetric forms, such as teardrops, flanged bodies, and dumbbells; their colors vary from dark green to blank. Some thin polished sections are nearly clear, but others include various shades of green, amber, and brown.

Tektites, estimated to be about 100 million years old, have been named and classified by their location. They are known as australites in Australia, rizalites in the Philippines, bediasites in Texas, moldavites in Bohemia, and billitonites in Borneo, and by other names, including Darwin and Libyan Desert glass. Probably the moldavites are the best known, since they were described as early as 1787. Bediasites, on the other hand, were not brought to scientific attention until 1936. Geological evidence indicates that tektites fell to earth at intervals within the last 50 million years.

Chemical analysis shows that tektites are composed of glass with a high silica content; their major secondary constituents are oxides of aluminum, iron, magnesium, calcium, sodium, and potassium. They have an unusually high melting point, 200 C above that of manufactured pyrex glass; a low coefficient of expansion; and high durability. Although some sedimentary rocks within the earth's crust are similar to tektites in composition, there seems to have been no natural heat source capable of fusing this type of glass on the surface of the earth within recent geologic time. Tektites have been found in quantities for centuries, but they have often been overlooked or casually collected for mundane use; they were made into weapon points by cave dwellers of paleolithic times, and used for jewels and ornaments in Australia during the gold-rush era and later in Texas, where they were known as black diamonds.

Many theories have arisen concerning the origin of tektites. One holds that they are remnants from prehistoric glass or iron works, but primitive man had no melting furnaces that could maintain the high temperatures necessary to fuse them. Another theory claims that tektites are splashings from the moon, although a conflicting theory indicates that even when the moon was formed as a molten mass temperatures were insufficient to produce such near-perfect glass. Still another theory, which suggests that tektites were formed by fusion of earth sediments when a meteorite struck the earth, has been disproved by studies showing that glass of this type could not have resulted from a flash reaction.

Most conjectures have been discarded in favor of the meteoric theory which became popular in the late 1890's. This approach considers the temperatures necessary to fuse tektite glass, the shapes found (particularly the flanged bodies), geologic information about the earth's structure, and the structure, composition, strain patterns, and inhomogeneities of tektites.

The meteoric theory postulates that tektite glasses, along with other glass silicates and meteoric material, must have been located somewhere on or near the surface of a planet (or planets) situated between Mars and Jupiter. The tektites could have formed when, in its development, the parent planet became a molten mass with an estimated temperature near 3000 C. Boiling and/or settling processes would have resulted in the concentration of the heavier materials in the planet's core, with lighter substances—the glasses and glass silicates—settling in layers or pools on or near the surface of the planet. Then, when the planet broke up, for some reason, these glasses were spread throughout space.

But how did this planet, if it existed, break up? And what became of the heavier parts? The theorists propose that the "lost" planet collided either with another similar planet or some other solar body, such as one of Jupiter's moons, and sent pieces flying off in all directions. Some of the pieces would have continued to circle the sun as meteors, comets, and asteroids, while others—the tektites—would have landed on the earth, the moon, and other planets and satellites. The small bits of glass that have been found scattered about the earth's surface, according to this theory are probably pieces of large meteoric chunks that flew apart under the heat and shock of landing.

So far, scientific study of the tektites has been somewhat neglected in favor of speculation as to their origin. If they are meteorites, however, further study of their structure may yield information on the theoretical lost parent planet, and consequently may contribute to our understanding of the earth's structure and the formation of the solar system.
—*Industrial Bulletin*, Arthur D. Little Co., Inc. May, 1956.

### The Sun at Work

THE Association for Applied Solar Energy, 204 Heard Bldg., Phoenix, Ariz., made initial world distribution of its newsletter, "The Sun at Work," late in March, 1956. The quarterly publication will serve to establish and maintain contact among persons concerned with solar energy research. Its purpose is to publish news of association activities as well as information about people and developments in the broad field of solar research.

The first mailing of "The Sun at Work," consisting of 10,000 copies, reached scientists, engineers, architects, and industrialists in 37 countries. Many of these people had attended the World Symposium on Applied Solar Energy held last year in Phoenix.

The newsletter's name is derived from the title of the Solar Engineering Exhibit held in conjunction with the symposium.

## 1956 Perkin Medal to Britton

EDGAR C. BRITTON, director of the Edgar C. Britton Research Laboratory of the Dow Chemical Co., Midland, Mich., and past president of the American Chemical Society, will receive the 1956 Perkin Medal of the American Section of the Society of Chemical Industry at a meeting of the Section following a dinner in his honor during the Perkin Centennial in New York the week of Sept. 10.

The 1956 award will be the 50th impression of the Perkin Medal, the highest honor in American industrial chemistry. It is bestowed annually for outstanding achievement in applied chemistry in the United States and commemorates the discovery of the first synthetic dye by Sir William Henry Perkin in 1856. Presentation of the medal this year forms part of the celebration of the centenary of Perkin's achievement.

The program for the Perkin Centennial in the United States is a cooperative effort of 27 participating societies including ASTM. Invitations to attend and other information about the Centennial have been sent to members of the various interested ASTM technical committees through their respective secretaries.

# The Challenge of Nuclear Energy Accepted by the Electric Power Industry and ASTM

## Annual Address by the President, June 19, 1956

C. H. Fellows

Director, Engineering Lab and Research Dept., The Detroit Edison Co.

As many ASTM'ers may know, I have spent nearly 35 years working on ASTM's technical committees, the last 25 years as a member of the Society. For nearly 40 years I have been associated with one company in the nation's great electric power industry. Within that time I have seen ASTM Standards—methods of testing and evaluation of materials and specifications—adopted in that industry for its great multiplicity of purposes.

Its construction programs employing cement, concrete, and steel have been controlled by this Society's specifications; its purchases of steel piping used in the generation and transfer of high-temperature steam have been controlled by those specifications; its selection of electrical insulating oils and lubricating oils has come to be made through the application of ASTM-developed test procedures; and the great variety of manufactured equipment comprising components of wood, paper, fabric, plastics, paints, and such metals as lead, copper, aluminum, and silver have been judged as acceptable or have been rejected upon the basis of ASTM Standards.

Mechanical and electrical engineers applied these Standards to the industry's business. Within the period of my association in it, the chemist and metallurgist have come to play ever increasingly important roles. And today a new scientist—the physicist—is called upon to contribute of his fund of knowledge to that of these others in the effort to meet the challenge created by the demand for more and more power.

Perhaps the most important step that has been made in the past 10 years toward the goal of more power, possibly at an even lower cost than prevails at present, has been that concerted effort by industry, and chiefly by the electric power industry, to develop the efficient application of nuclear energy for the generation of electric power.

Until now you have had no clue as to the theme of this address. After all, a theme, as someone once said, is just a point of departure from which a speaker may wander for forty or fifty minutes. I can assure you, I have done just that during the past 18 months while I debated the question of what subject to speak on today. Many of you are more closely associated with the industrial application of nuclear energy than I am, but I believe most of you will be interested in the present status of that effort, begun in 1950, by the Dow Chemical Co. and Detroit Edison Co. to examine the possibilities of the development of an economically competitive nuclear-energy heat source in the generation of electric power.

May I take just a few minutes to tell you of this project and, I hope, show you how ASTM with its logical and systematic approach to the materials problems of industry is now diligently concerning itself in this new area of evaluating the measurable physical effects of nuclear radiation of materials.

APDA—Atomic Power Development Associates—is the outgrowth of the original Dow Chemical-Detroit Edison group of associates from which Dow Chemical later withdrew. This group comprises 33 electric power companies and 12 engineering and manufacturing firms. It is a nonprofit membership corporation of United States industries, having as its primary objective the development of the heat of nuclear fission into a commercially practicable means of electric power generation.

Specifically this corporation was commissioned to design and develop a liquid-metal-cooled, fast breeder reactor having a gross electric output of 100,000 kw with steam conditions defined as 600 psi and 750 F. The estimated cost was to be $45,000,000.

PRDC—Power Reactor Development Company—comprising 18 electric power companies and 8 engineering and manufacturing companies was organized to build, own, and operate the reactor designed by APDA.

APDA's objective is a continuing one. While PRDC builds and operates this initial reactor, the earlier group will continue its studies, because it is recognized that this first power reactor will not be an economically

competitive unit and that through experience with it, new designs will be born that will enable the engineers to more closely approach the ultimate objective.

Even today there will be some who question the need for developing nuclear power. Many have wondered why such large sums of money and so many manhours have been expended in its development. Actually, there are three very important reasons.

First, our ever-increasing requirements for energy dictate that we supplement, and use more effectively, our present conventional fuels. During the past ten years, the electric power industry has more than doubled its output and has increased its conventional fuel consumption nearly 100 per cent. It is expected that an equal growth will result during the next decade. With this increase in fuel consumption, we must concern ourselves with future availability of conventional fuels. Data compiled by the Atomic Energy Commission indicate that the known world deposits of uranium and thorium represent, assuming full utilization, some 23 times the heat equivalent of the world's conventional fuel deposits. This then constitutes an urgent reason for the development of atomic power.

The second reason for developing this type of energy is the possibility of pro-

ducing power at a lower cost. We believe that there lies within the atom, this potential.

Power costs vary greatly, even throughout the United States, depending largely upon the availability of fuel. Therefore, what is economic power in one locality may not prove to be economical in other areas or other countries. It is evident that in the New England area, where fuel costs are as high as 40 to 50 cents per million Btu, nuclear power can be justified much more readily than in the Southwest, where fuel costs are on the order of 10 to 15 cents per million Btu.

Then too, coal costs are ever increasing, and consequently, if power companies are to maintain low rates, as they have in the past, it is imperative that further engineering techniques be developed. We look to nuclear energy as a means of eventually producing lower-cost power, provided, of course, that costs of labor, taxes, and construction materials remain at or near present levels.

The third reason for developing nuclear energy is the political aspects of the world race for the peaceful use of the atom. This is probably one of the strongest motivations for our Government to solve this problem. President Eisenhower's international program and the formation of the Fund for Peaceful Atomic Development are significant steps toward this end.

The APDA group in Detroit is now working on the development of what is called a breeder-type reactor in which more fissionable fuel is created than is burned. Actually very little practical experience is available with the breeder-type reactor. Argonne National Laboratories constructed and has operated since late in 1951 the EBR I (Experimental Breeder Reactor No. 1) at the National Reactor Testing Station, Arco, Idaho. They are now designing a second breeder reactor of 60 Mw heat output to be known as EBR II.

Fuel costs are greatly reduced with this type of operation, but unfortunately, there are offsetting disadvantages. Fixed charges are high, associated with a large inventory of valuable materials. Expensive fuel processing also is a major problem with this type of reactor.

Each type of reactor has its own characteristic advantages as well as disadvantages. At this period in reactor technology, it is not possible to state which of these represents the best over-all solution to economical nuclear power. Because of the many unknowns, it was necessary that additional experience be obtained with a large variety of reactors. During the early part of 1954, the AEC announced its 5-yr reactor program. This program encompassed the development of five different reactor concepts. It was undertaken in an effort to assist in advancing reactor technology and civilian use of nuclear power.

This program includes:

1. pressurized water reactor,
2. experimental boiling water reactor,
3. sodium-graphite reactor experiment,
4. experimental breeder reactor No. 2,
5. homogeneous reactor.

Paralleling this AEC reactor program and in addition to it, there is the so-called "Reactor Demonstration Program for Industry." This is being carried on by private industry and includes numerous utilities, equipment manufacturers, engineering and construction firms, chemical companies, shipbuilding companies and others working together to advance the field of reactor technology and nuclear energy. In this program, commercial reactors of each of the types mentioned earlier are planned for construction.

In the case of the **pressurized water reactor,** the Yankee Atomic Electric Co. including 12 utility companies is considering constructing a plant at Rowe, Mass., that will have a capacity of about 130,000 kw.

The Consolidated Edison Co. of New York is also considering constructing a plant using a reactor of this type at Indian Point, N. Y. This plant will have a capacity of 150,000 kw.

The Commonwealth Edison Co. and its associates are planning construction of a plant at Dresdon, Ill., using the **experimental boiling water reactor** that will have a capacity of 180,000 kw.

The **sodium-graphite reactor experiment** is a responsibility of the North American Aviation Co. It will be constructed at Santa-Susana, Calif. The Southern California Edison Co. will install turbine equipment to utilize the steam.

The Consumers Public Power District of Nebraska has AEC approval to install a plant of this type that will have a capacity of 75,000 kw.

The Nuclear Power Development Co. including The Detroit Edison Co. and 25 associates will construct the **developmental breeder reactor** plant south of Detroit. It will have a capacity of 100,000 kw.

Besides the two **homogeneous reactors** being developed and studied by the Oak Ridge National Laboratories there is one under consideration jointly by the Pennsylvania Power and Light Co. and Westinghouse for large scale power generation. Reactors of this type are significantly different from the others in that the finely divided fuel, either uranium or thorium, is suspended in water and pumped through the reactor vessel.

This is a program in which over $300,000,000 of private money is being spent. It is the largest research effort ever undertaken in which the electric power industry is taking the leading role.

As I stated earlier, APDA designed and developed a liquid-metal-cooled, fast breeder reactor; PRDC will build and operate it. It is to be built on a site some 30 miles south of Detroit near the west shore of Lake Erie. Ground is expected to be broken for this new privately owned plant on August 8, 1956, the anniversary of the Geneva Atomic Energy Conference in 1955. This anniversary date, we believe, will be historically significant. It will be completed in 1960.

ASTM is also fully aware of the impact which the extensive use of nuclear energy will make in regard to materials testing programs. It may interest you to know that ASTM has already undertaken talks with AEC representatives for the purpose of exploring ways by which the Society with its organized committee setup might best serve industry and AEC in the area of developing standard tests for the structural materials of atomic reactors and materials of accessory equipment.

It was the consensus of a meeting attended by representatives of selected ASTM Technical Committees that the Society proceed at once to initiate programs within the framework of its committee organization toward the end that standard test methods and ultimately specifications could be developed. This recommendation was approved by the Board of Directors at its January meeting. An Advisory Committee was appointed. It will function as an administrator and coordinator that will guide ASTM's activities in this new field, both with respect to power and other applications. Our membership can feel assured that ASTM is taking the significant part it should take in the development of this important new source of power for American as well as worldwide industry.

Although we have made significant steps forward in reactor technology, we still have a long way to go. The nuclear power industry stands today where conventional-fueled steam power did fifty years ago.

Great advances have taken place in the production of electrical energy largely because of the efforts of the elec-

tric power industry and the manufacturers of electrical apparatus and equipment. I am confident that equally important developments in power generation using nuclear reactors as heat sources will also come in the years ahead.

I am equally confident that as our ASTM Technical Committees contributed significantly to the development of materials for present-day power plants, those same committees augmented in some instances by new personnel will make a like contribution in this area of generation using nuclear energy.

Throughout this entire discussion I have emphasized the striking progress the electrical power industry has made in the direction of developing and adapting to its own purposes this energy from the atom.

In closing, I should like to leave this thought with you: I quote:

> Man is not master of the universe because he can split the atom. He has split the atom because he believed in his own unique mastery. Faith led to the material achievement, not the achievement to the faith.

# The Stress-Hardness Relation

By Aram Dervishyan

**A theoretical and experimental study of the stress-hardness relation is treated in this paper. The theoretical study is based essentially on the Herz-Huber theory, and it is assumed that yielding occurred when the shear stress reached a maximum. Some important results were deduced from this theoretical consideration. Special instruments were designed and built for investigating the stress-hardness relation.**

**The experimental results showed that stress and hardness as defined in this paper have a linear relationship, and the possibilities of using this method for determining the stress in already built structures is intimated.**

A RESEARCH program was undertaken in 1952 at the University of California at Los Angeles, sponsored by the U. S. Army Office of Ordnance Research, with the view of investigating the stress-hardness relation and the feasibility of determining stress by hardness measurements.

This work, which was both theoretical and experimental, was carried out over a period of two years. The results of this research are presented in this paper.

## Theoretical Considerations

A theoretical study of the stress field created by a spherical ball pressing on a flat surface was made using the Herz-Huber equations which are based on the theory of elasticity, and the following are the results of the study:

1. The maximum shear stress $\tau_{max}$ does not occur at the surface but beneath the surface at $Z_0 = 0.48\ \alpha$ where $\alpha$ = radius of indentation. This is found by finding the maximum shear stress which is one-half the difference between the maximum and minimum principal stresses (expressed in terms of Z) differentiating $\tau$ with respect to Z equating to zero and solving for Z (**5**).[1]

2. The magnitude of $\tau_{max}$ is given by $\tau_{max} = 0.31q_0$, where $q_0$ is the maximum compressive stress at the center of the surface of indentation. This is obtained by substituting the value of $Z_0 = 0.48\alpha$ in the maximum shear stress expression. (See Fig. 1.)

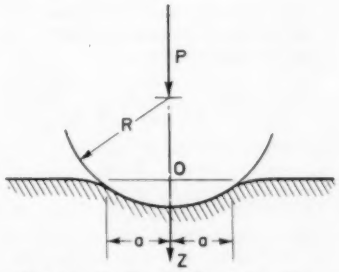


**Fig. 1.—Sphere Pressing on a Flat Surface**

The following symbols are used throughout the paper:

$\sigma$ = applied uni-axial stress,
$\sigma_y$ = yield stress of specimen,
$\tau_{max}$ = maximum shear stress,
$\alpha$ = radius of indentation,
Z = depth of indentation,
$R$ = radius of spherical indentor,
$P$ = load acting on ball,
$\nu_1$ = Poisson's ratio of indentor,
$\nu_2$ = Poisson's ratio of specimen,
$E_1$ = Young's modulus of indentor,
$E_2$ = Young's modulus of specimen,
$K_1 = \dfrac{1 - \nu_1^2}{\pi E_1}$, and
$K_2 = \dfrac{1 - \nu_2^2}{\pi E_2}$.

From Timoshenko and Goodier (**4**), we have for a ball of radius $R$ pressing with a force $P$ on a surface

$$\alpha = \left[\frac{3\pi}{4} PR(K_1 + K_2)\right]^{1/3} \quad \ldots\ldots(1)$$

$$Z_0 = \left[\frac{9\pi^2}{16} (K_1 + K_2)^2 \frac{P^2}{R}\right]^{1/3} \quad \ldots\ldots(2)$$

$$q_0 = \frac{3}{2}\frac{P}{\pi\alpha^2} = 0.27\left[\frac{P}{R^2(K_1 + K_2)^2}\right]^{1/3} \quad \ldots\ldots(3)$$

Now the position of maximum shear stress is at $Z_0 = 0.48\alpha$ and its magnitude is $\tau_{max} = 0.31q_0$

$$\tau_{max} = 0.31q_0 = 0.0837\left[\frac{P}{R^2(K_1 + K_2)^2}\right]^{1/3} \quad \ldots\ldots(4)$$

**ARAM DERVISHYAN was research engineer, Department of Engineering, University of California at Los Angeles when the work described here was done. At present he is with Sciaky Bros. Corp., Santa Monica, Calif., working on application of resistance welding to aircraft.**

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

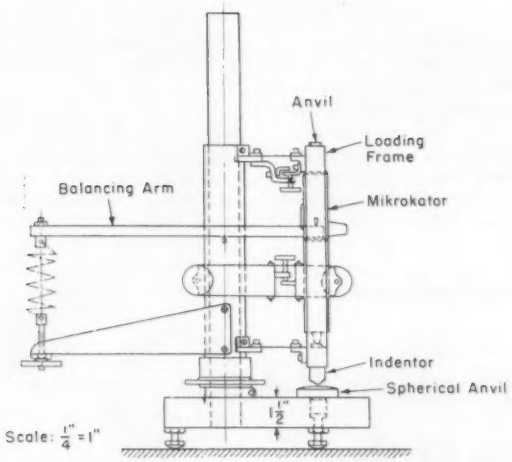


**Fig. 2.—The Hardness Tester.**
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Now if we assume that yielding in the specimen material occurs when the shear stress reaches a maximum, that is, $\tau_{max} = \sigma_y/2$, then

$$\sigma_y/2 = 0.0837 \left[\frac{P_{max}}{R^2(K_1 + K_2)^2}\right]^{1/3} \quad \ldots(5)$$

where $P_{max}$ is load on indentor when $\tau_{max} = \sigma_y/2$ and solving for $P_{max}$ we get

$$P_{max} = 213.17(K_1 + K_2)^2\sigma_y^3R^2$$

If we consider steels, taking $\nu = 0.3$ and $E = 3 \times 10^7$ psi, then

$$P_{max} = \frac{7.949}{10^{14}}\,\sigma_y^3R^2 \quad \ldots(6)$$

If we take the specimen to be mild steel with $\sigma_y = 4 \times 10^4$ psi then

$$P_{max} = 5.088R^2 \quad \ldots(7)$$

and is parabolic, and it is seen that $P_{max}$ varies as the square of the radius of the spherical indentor.

Substituting Eq 7 in Eqs 1 and 2, we get

$$\alpha = 0.00614R \quad \ldots(8)$$

$$Z_0 = 3.77 \times 10^{-5}R \quad \ldots(9)$$

and both of them vary linearly with $R$.

Note that $\frac{\alpha}{Z_0}$ is a constant and for steel it is

$$\frac{\alpha}{Z_0} = \frac{0.00614}{3.77 \times 10^{-5}} \cdot \frac{R}{R} = 153 \quad \ldots(10)$$

*Flat Surface Subjected to a Uni-axial Tensile Stress.*—Now if a uni-axial tensile stress $\sigma$ were the only acting stress, then the maximum shear stress would be

$$\tau_{max} = \frac{\sigma}{2} \quad \ldots(11)$$

Assuming linearity and, hence, superposition to be valid, if both stress systems act simultaneously, the maximum shear stress will be

$$\tau_{max} = 0.0837 \left[\frac{P}{R^2(K_1 + K_2)^2}\right]^{1/3} + \frac{\sigma}{2} \quad \ldots(12)$$

If we assume again that yielding occurs when the maximum shear stress of the material is reached, that is $\tau_{max} = \sigma_y/2$, then we get

$$\sigma_y/2 = 0.0837 \left[\frac{P_{max}}{R^2(K_1 + K_2)^2}\right]^{1/3} + \frac{\sigma}{2}$$

$$P_{max} = 213.17R^3(K_1 + K_2)^3\,(\sigma_y - \sigma)^3 \quad \ldots(13)$$

Substituting this in Eq 1 we get

$$\alpha = 7.949(K_1 + K_2)\,(\sigma_y - \sigma)R \quad \ldots(14)$$

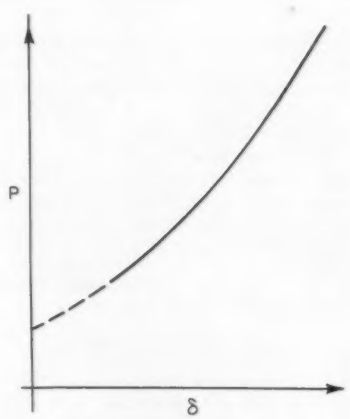


**Fig. 3.—Load Deflection Curve.**

The position of maximum shear stress is at $Z_0 = 0.48\alpha$

$$Z_0 = 3.82(K_1 + K_2)\,(\sigma_y - \sigma)R \quad \ldots(15)$$

We can draw the following conclusions from Eqs 13, 14, and 15:

1. *From Eq 13:* If $\sigma$ is tensile, the higher the value of $\sigma$, the smaller the load $P_{max}$ required to cause the first indentation. In other words, the $P_{max}$ would correspond to a material with a low yield stress.
2. *From Eq 13:* If $\sigma$ is compressive, then it appears that the $P_{max}$ necessary to cause the first indentation will be higher. However, in the case of compression, shear failure will occur on a different plane (6). On this plane, the compressive stress will have no effect and shear failure will be the same as if no uni-axial compressive stress were applied.
3. *From Eq 14:* It is seen that the radius of the indentation in the direction of the stress is a linear function of $\sigma_y$, $\sigma$, and $R$; and that if $\sigma$ is tensile, then as $\sigma \to \sigma_y$ the radius $\alpha \to 0$.
4. *From Eq 15:* It is seen that the position of maximum shear stress is a linear function of $\sigma_y$, $\sigma$, and $R$; and that if $\sigma$ is tensile, then as $\sigma \to \sigma_y$, $Z_0 \to 0$, that is the position of maximum shear stress approaches the surface.
5. *From strain considerations:* If $\sigma$ is tensile and since yielding is occurring the radius $\alpha$ in the direction of the stress $\sigma$ will be longer than the radius in a direction normal to the stress $\sigma$. Hence the dent may be of elliptical shape instead of circular.

## Experimental Testing

Having shown that theoretically the load causing the first dent is a function of the stress, an experimental setup to test this theory was next considered.

From Eq 7 it is seen that for mild steel and with $R = \frac{1}{2}$ in., the load causing the first dent is about 1.27 lb, and from Eq 13 it is seen that $P$ would decrease with increase of tension stress $\sigma$. Hence, an instrument was required that could apply light loads.

Next a means of observing the occurrence of the first dent was considered. At this stage, G. Sines, who was project leader at that time, suggested the principle of an instrument. This is mainly a load-deflection instrument, that is, a certain load $P$ is applied on the ball, and the penetration of the ball (sum of elastic and plastic) is read on a sensitive instrument, known under the trade name of "Mikrokator" which can read to an accuracy of 0.000002 in. (**1, 2, 3**).

A sketch of the instrument is shown in Figs. 2 and 4. It consists of a heavy aluminum loading frame in which a large opening is cut out providing space

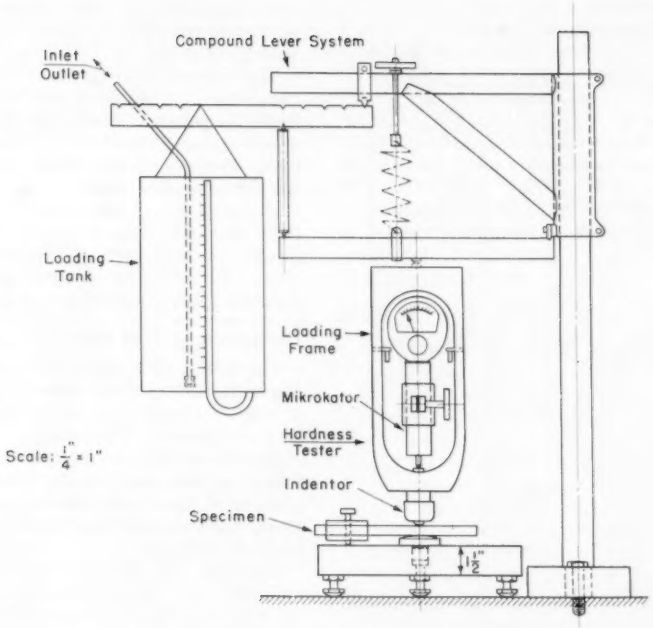


**Fig. 4.—Hardness Tester and Loading System.**
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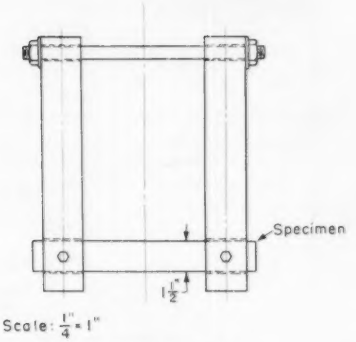


**Fig. 5.—Stress Frame.**
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for the Mikrokator. The Mikrokator is supported by means of an adjustable bracket attached to a long tube which can slide and rotate on a fixed vertical column, while the feeler of the Mikrokator rests on the bottom of the loading frame. The loading frame is attached to the vertical tube by means of flexures. As these flexures are too weak to support the weight of the frame, a balancing arm is provided which, by means of an adjustable spring, allows the frame to float. The long tube mentioned above rests on a knurled nut which by its rotation gives to the tube a vertical motion. The instrument is lowered in balanced state on the specimen, and the instant of contact of the indentor with the specimen can be observed by the motion of the pointer on the Mikrokator after which the indenting load is applied on the specimen.

The first method adopted in determining the initial plastic dent was as follows:

The reading $A$ of the depth gage on the instrument is read. Next, a load $P_1$ is applied. The load is removed, and the reading $B$ taken. If the load is gradually increased, a load will be reached at which there will be some difference between $A$ and $B$. This difference would be the plastic penetration. If the difference $(A-B=\delta)$ at each load $P$ be found, then the total penetration up to a load $P$ will be the sum of all the penetrations up to that load. If the total penetration at each load $P$ is found and is plotted against the corresponding value of $P$, a curve similar to Fig. 3 would result. Upon extrapolating this curve to $\delta = 0$, the load $P$ is found which will cause the first plastic dent. This particular value of $P$ was taken as the hardness number in this paper.

The means of applying the load $P$ on the indenting ball caused some difficulty due to the facts that:

(1) The slightest impact jerked the reading of the "Mikrokator" depth gage; (2) it was found that the "Mikrokator" reading drifted with time, hence the test must be made as fast as possible.

The above reasons led to the development of a compound lever system which could multiply the applied load from 2 to 18 times, refer to Fig. 4. The loading medium was kerosine flowing by gravity into a loading tank and, for unloading, the kerosine is siphoned out. The inlet-exit tube leading into the loading tank hanging from the compound lever system did not touch any part of the system, and this tube had a special baffle at its end to break kinetic energy effects of the incoming fluid. A glass tube was attached to the tank and was calibrated to read the level of liquid in the tank in pounds force.

## Test Results

The material used was hot-rolled mild steel. The surface to be tested was ground, and then polished by hand to No. 0000 metallographic paper. The test results in unstressed condition were satisfactory, but when the specimen was stressed, the results proved to be unsatisfactory. This brought out the question about possible residual stresses in the specimen. X-ray tests showed

TABLE I.—CALIBRATION TEST RESULTS FOR HOT-ROLLED MILD STEEL IN NORMALIZED (870 C) STATE.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Tensile stress, psi | 0 | 3000 | 6000 | 10 000 | 14 000 | 18 000 | 22 000 | 26 000 | |
| Load, $P_{max}$, lb | 11 | 10.4 | 9.6 | 8.0 | 7.4 | 6.4 | 5.6 | 4.4 | |
| Standard deviation, $S$ | 1.74 | 2.12 | 1.50 | 1.47 | 1.41 | 1.73 | 1.11 | 0.92 | |
| | | | | | | | | | |
| Compressive stress, psi | 0 | 3000 | 6000 | 10 000 | 14 000 | 18 000 | 22 000 | 26 000 | 30 000 |
| Load, $P_{max}$, lb | 11 | 13 | 11.7 | 12.1 | 11.8 | 13.7 | 12.2 | 13.6 | 12.6 |
| Standard deviation, $S$ | 1.74 | 2.47 | 2.06 | 1.84 | 1.70 | 1.46 | 1.27 | 1.45 | 0.97 |

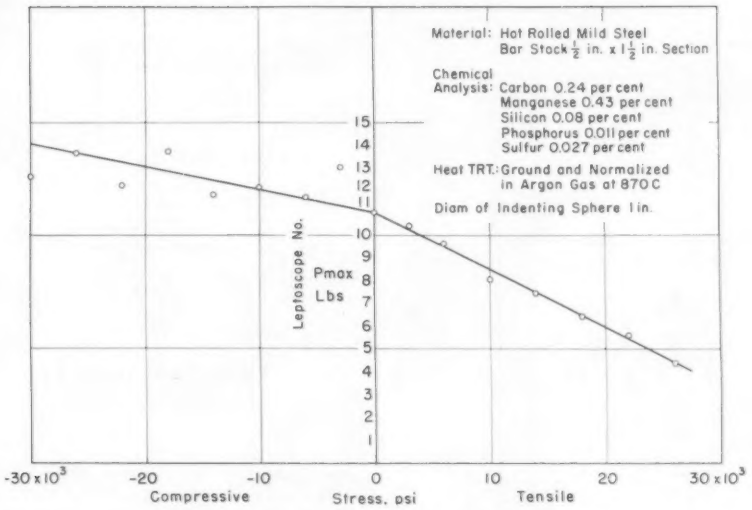


Fig. 6.—Calibration Curve.

that the hot-rolled specimen had very high residual stresses.

Another specimen was prepared, ground, and then normalized in inert gas at 870 C for 30 min, and then air cooled together with the flask. X-ray tests showed that the residual stresses were eliminated. Next the specimen was polished by hand to No. 0000 metallographic paper. The effect of the heat treatment was also to reduce the crystal size by about one-half, making the material more uniform.

With the normalized specimen, drift effects, in the Mikrokator mentioned above were comparatively of no consequence owing to the fact that the material had now a well-defined yield characteristic.

Generally, as the load on the indentor increased, the reading of the Mikrokator increased correspondingly. It was observed that when the load reached a certain magnitude, the pointer of the Mikrokator would jerk forward in the direction of increased penetration. In most of the tests, this sudden "jerk" or "jump" would occur after the pointer came to a stop for a moment.

The moment this "jump" occurred, the loading was stopped, and thus the load on the indentor at the moment of jump would be known. It was observed that no permanent dent on the specimen could be observed unless this "jump" occurred. Hence the load at the "jump" was taken to be the load at which the first plastic dent occurred. In all the test results, the dent had to be observed visually (Blain method) (7) before the test result would be accepted.

To test the specimen in stressed condition, it was put in a special frame, Fig. 5, which applied a uniform bending stress in the specimen so that fibers at the same distance from the neutral plane had the same stress all along the test section. Briefly, the testing method consisted of increasing the load continuously by 1-lb increments. Each time the load was increased by 1 lb, it was timed to remain for 10 sec, as it was observed that there was a time factor involved. Generally, yield occurred within 10 sec, and also while the load was being increased, but in several instances yielding occurred after 20 to 30 sec.

The test results are given in Table I. Generally 12 tests were run at each stress; hence each point in Fig. 6 represents the average of 12 tests. However, for the unstressed state, 32 tests covering the entire testing surface were made. The reason for so many tests was to check the uniformity of the surface before proceeding further in the test program. In all of these tests, a 1-in. diameter spherical indentor was used.

### Discussion of Test Results

The values of Table I are plotted in Fig. 6 and the resulting curve is known as the calibration curve for this particular material and heat treatment.

As one can observe, the relation between hardness and tensile stress appears to be linear while the relation between hardness and compressive stress is not well defined.

Note that with zero stress, $P_{max} = 11$ lb while with a tensile stress of 26,000 psi, $P_{max} = 4.4$ lb or a change of hardness of $\frac{(11 - 4.4)}{11} \times 100 = 60$ per cent.

The equation of the curve is

$$P_{max} = 11 - 2.527 \times 10^{-4}\,\sigma \quad \ldots\ldots (16)$$

and for $P_{max} = 0$, we have $0 = 11 - 2.527 \times 10^{-4}\,\sigma$ ($\sigma = 43{,}500$ psi) and this is close to the yield stress in tension of the material which was found to be, from two tests, 47,000 psi.

It is probable that the curve approaches asymptotically the stress axis, so that equating Eq 16 to zero may be an approximation.

It is seen from Fig. 6 that the compressive part of the curve is not as well defined as the tension part and that, in general, there is a small increase in hardness. With reference to Sines and Carlson (6), a description of the mechanism of yielding under the indentor is given, and this explanation may be extended to explain the small increase of hardness when a compressive stress is acting.

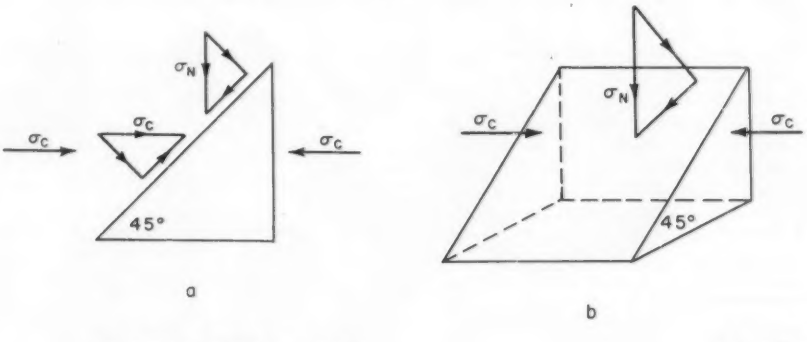


Fig. 7.—Diagram of Stresses Showing Possible Yielding by Shear on 45-deg Plane.

From Fig. 7(*a*), the shear stress induced by the compressive stress is acting opposite to the shear induced by the stress $\sigma_N$ due to the indentor, so that shearing along the transverse plane will be prevented. However, from Fig. 7(*b*) it is seen that the compressive stress $\sigma_c$ has no effect on the longitudinal plane, and hence shearing will apparently occur under the same stress $\sigma_N$ as when no compressive stresses were acting.

Note also that the crystals are inclined in all directions and each has its own particular slippage planes. Consequently, owing to the compressive stress, some restriction is imposed as to which direction slippage will occur, and this might explain the small hardness increase due to the compressive stress.

Note that in the above explanation it was assumed that yielding occurred when the material reached its maximum shear stress on a 45-deg plane. It may be that shearing is the cause of yielding, but when the maximum shear stress theory was used together with the Herz-Huber equations, the curves showed up to be cubic (Eq 13) owing to the fact that the Herz-Huber equations are based on the theory of elasticity and seemed not to be valid in the region of the yield stress of the normalized mild steel specimen. The magnitude of the inconsistency between experimental and theoretical results can be seen from the following values:

From theory using Eq 7 with $R = \frac{1}{2}$ in. $P = 1.27$ lb (zero stress).
From experiments for $R = \frac{1}{2}$ in. $P = 11$ lb (zero stress).

Apparently for the normalized mild steel specimen, a new approach based on some elasticity-plasticity theory may be necessary to get results in harmony with the experiments.

As can be observed from Table I, the standard deviations varied for the tensile stress branch of the curve from 0.92 to 2.12, and there is a tendency for $s$ to decrease with tensile stress. This means that in order to have a representative hardness value for a given stress, many tests have to be made and the average taken. Also, that it would be preferable to carry the tests on as wide an area as possible in order to have a better representative value of the load for that particular material under that particular stress.

## Conclusions

1. Figure 6 shows that hardness (as defined here) when accurately determined is a function of the tensile stress, but not so much of compressive stress.

2. The fact that hardness is a function of tensile stress may be used to determine stresses in structures (residual, too) if the calibration curve for that particular material is available. This is done by making a series of hardness tests finding the average value of $P_{max}$, then by referring to the calibration curve, the corresponding stress is determined.

3. If further experiments show that the calibration curve obtained by the method described above is always linear, then a simple method of getting the calibration curve would be to find the value of $P_{max}$ for $\sigma = 0$ only, since the other end of the curve would pass through the point $P_{max} = 0$ for $\sigma = \sigma_y$, and generally $\sigma_y$ of a material is known.

4. Research work is necessary to develop some elasticity-plasticity theory to get theoretical calculations in harmony with experiment.

5. Research on the effect of various size indenting balls, grain size and differences in materials should be made. Effect of heat treatment should be investigated.

6. Develop better instrumentation for cases where drift effects make results questionable.

The stress hardness relation has many potential applications (for example, determination of stresses in a tire shrunk on a wheel) and further research in developing practical field instrumentation should be made.

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# An Apparatus for Measuring the Response of Polymeric Materials to an Oscillating Strain*

By Bryce Maxwell

*Under controlled conditions of temperature and strain magnitude, the real and imaginary components of the dynamic modulus and the mechanical loss factor may be determined over a wide frequency range with this apparatus.*

*Data on cellulose acetate, cellulose acetate butyrate, polyvinyl chloride demonstrate the response of typica plastics and the use of this apparatus in categorizing the time- and temperature-dependence of the properties of visco-elastic materials.*

THE dynamic mechanical properties of visco-elastic materials have been the subject of many recent investigations (1–5).[1] In most cases the interest in these properties stems from a desire to correlate the time-dependent response of these materials with their molecular structure. The data obtained by these investigations is in some cases also of direct value in the understanding of the mechanical engineering properties of plastics for design considerations. Since the response of these materials is dependent on the time scale of mechanical stressing or straining, the behavior of visco-elastic materials under specific loading conditions such as impact, abrasion, indentation, and fatigue will also be time dependent (6).

To evaluate each engineering property over the time scale of loading and temperature range of useful application would be a very time consuming undertaking for any single plastic material. When we consider how many materials there are today that would have to be studied under controlled conditions with respect to these two variables, the size of this undertaking becomes discouragingly large. In order to reduce this job, current investigations are directed toward categorizing or describing the general time dependent behavior by means of a single dynamic test (7,8).

Ideally such a test should involve the simplest possible piece of apparatus and test manipulation should be reduced to a minimum. One test setup and one test sample on which data over a wide frequency and temperature range could be obtained would be preferable. In an earlier report (8) such a method was described in which each fiber of the specimen was subjected to a sinusoidally-oscillating tension and compression stress. The magnitudes of the maximum tensile and compressive stresses were equal and controlled. The apparatus described below operates on the same general principle but is modified so that a controlled oscillating tensile and compressive strain is applied to the specimen.

The use of a controlled strain rather than a controlled stress is desirable from both practical and theoretical considerations. On the practical side, controlled strain is desirable in view of the need to test materials over a wide modulus range. If for example some specific maximum stress per cycle were specified in a test procedure the strain would be dependent on the modulus of the material. If the modulus were very high the strain might be too small to measure. If the modulus were very low the strain would be very large, resulting in failure of the specimen. By using a constant controlled maximum strain-type dynamic test it is possible to cover any modulus range consistent with the sensitivity of the stress measuring device used without breaking the specimen. This is inherently true since below the yield point, the strain a specimen can stand is not reduced by the modulus changing variables but the stress is reduced. For example, as the temperature is increased the breaking strain increases but the breaking stress decreases.

From the theoretical point of view the analogy may be drawn between the constant stress per cycle dynamic test and the so-called static creep test. Similarly there is an analogy between the constant strain per cycle dynamic test and the stress relaxation test. Since the constant stress-type test produces an uncontrolled strain, structural change can take place in the specimen due to the strain. But if the strain is controlled and the stress measured it is possible to stay within the linear region of response in the material.

Similarly if it is desirable to test for dynamic response beyond the yield point (that is, in the nonlinear region) this can be done more easily with the controlled strain-type test since the location of the yield point on the strain axis does not vary with time and temperature but the location on the stress axis does.

### Basic Theory

The response of polymeric materials to mechanical stress or strain is considered to be visco-elastic. The truly elastic component of the response is dependent on the stiffness of the chain backbone of the molecules. The viscous or visco-elastic components of the response are dependent on the bonds con-

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

trolling configurational changes in the chain segments and the displacing of one chain with respect to another. With such a combination of elastic and viscous behavior it is apparent that the properties of these materials will change with the rate of application of stress or strain and the temperature of testing.

The rate at which chain uncoiling and chain-chain slipping takes place is dependent on the relaxation times of the bonds restraining these mechanisms of response. If the rate of straining is so rapid that these bonds cannot relax, then these mechanisms of response cannot take place. The relaxation time of the bonds will decrease with an increase in temperature. It becomes apparent that our problem is to determine these characteristics of the response as they are affected by frequency and temperature.

The application of an alternating strain will produce in the steady state condition a sinusoidal stress which is partly in phase with the strain and partly in quadrature. The complex elastic modulus $E^*$ will then be made up of the real or in-phase component $E'$ and the imaginary or 90 deg out-of-phase component $E''$.

$$E^* = E' + iE'' \quad \ldots\ldots\ldots (1)$$

The ratio of the imaginary to the real modulus is defined as the loss factor

$$\tan \delta = \frac{E''}{E'} \quad \ldots\ldots\ldots (2)$$

The relative magnitudes of $E'$ and $E''$ will change with frequency for viscoelastic materials. The ratio of $E''$ to $E'$ will reach a maximum at the natural frequency associated with the viscous and elastic components of each bond mechanism that forms the cohesive forces in the material.

The principle of operation of the dynamic type testing apparatus used in these studies was first analyzed by Kimball (9) from observations made by Mason (10). This principle has been used by several other workers in this field but only for the condition of applied constant stress per cycle, not for constant strain, and only over a narrow frequency range.

A cantilever beam specimen of circular cross-section (Fig. 1) is mounted in a chuck or collet so that it can be rotated about its cylindrical axis. If the unsupported end of the specimen $A$ is deflected to some point $B$, each fiber of the beam will receive a strain that will alternate from compression to tension sinusoidally with the frequency of rotation. The resulting stress due to this alternating strain can be determined by measuring the force required to hold the end of the specimen deflected to $B$.

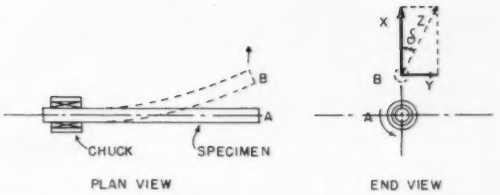


Fig. 1.—Schematic Diagram of Principle of Operation of Equipment.

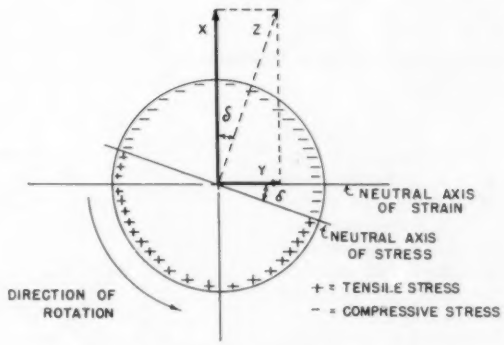


Fig. 2—Stress Distribution in Visco-Elastic Specimen.

If the material being tested is ideally elastic, the force represented by the vector $X$, coincident with the direction of deflection of the end of the specimen, is all that is needed. From a knowledge of the dimensions of the specimen and the force $X$, the modulus of elasticity of the material can be found.

If the material being tested is viscoelastic, the stress in each fiber of the specimen will lag behind the applied strain, Fig. 2. Some force $Y$ perpendicular to $X$ must be applied to hold the end of the specimen at point $B$. From a knowledge of the force $Y$ and the dimensions of the specimen, the imaginary modulus $E''$ can be calculated.

The direction of the resultant vector $Z$ lags behind the applied strain by the angle $\delta$ which is equal to the angle between the neutral axis of strain and the neutral axis of stress. The ratio of $Y$ to $X$ gives the tangent of this angle and the loss factor.

Previous machines based on the rotating-beam principle have used a constant-stress type loading by the application of a weight to the free end of the specimen and the response of the specimen determined by the observation of the location of the end of the specimen. In this type of setup some damping device must be applied to prevent whirling of the weight on the free end. As a result, the specimen must be under load for some time while the damping device reaches a steady state position. This results in fatigue or build up of heat in the specimen. With the constant-strain type apparatus no damping equipment is needed as the force-detecting device will restrain the motion of the free end.

The advantages of determining dynamic mechanical properties by this rotating-beam constant-strain type test may be summarized as follows: (1) The test may be performed over a wide frequency range by varying the rate of rotation of the chuck. (2) The same specimen geometry can be used for any frequency. (3) The force detecting elements to determine $X$ and $Y$ need not be able to respond at the test frequency since the forces measured are essentially static. (4) There is no need for damping devices to prevent whirling of the free end since the force detecting elements restrain it.

## Apparatus

The apparatus is shown schematically in Fig. 3. The specimen $A$ is a transfer-molded rod $3\frac{1}{2}$ in. long and $\frac{1}{4}$ in. in diameter. It is mounted in a variable expansion collet $B$ fastened to the shaft of a ball bearing quill $D$, and is en-

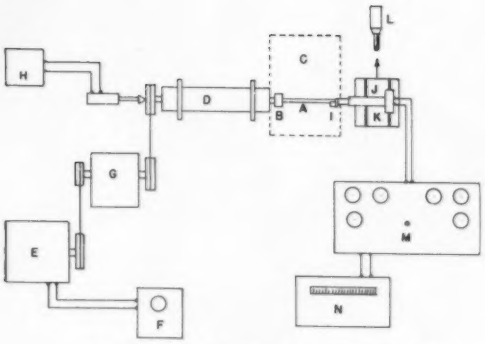


Fig. 3.—Schematic Diagram of Apparatus.

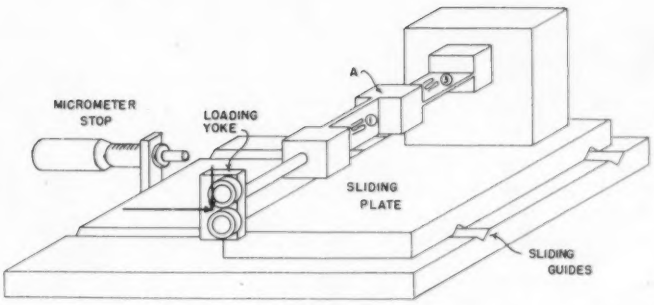


Fig. 4.—Details of Load Sensing Element.

closed in an air thermostat *C*. The drive is supplied by a $\frac{1}{20}$ hp dc motor *E* with variable speed controller *F*. In order to cover a wide frequency range in an infinite number of steps various combinations of pulleys and gear reducers *G* may be used. The angular frequency is determined by a tachometer *H* attached to the shaft of the quill.

The strain is applied to the free end of the specimen by means of a ball bearing yoke *I* attached to the force detecting elements *J*. The force detecting device is rigidly supported on a plate *K* which can be moved sideways to apply the strain. The amount of strain applied is determined by the micrometer stop *L* which can be preset to the desired amount of deflection. *M* contains the force sensing device controls and *N* is a 0.005 microamp per mm galvanometer with a 5-sec period.

The details of the force-detecting element are shown in Fig. 4. The dynamometer *A* is machined from cold-rolled steel. Two thin beams are thus produced, one of which will be sensitive to force in the horizontal direction and the other will be sensitive to vertical forces. The ball bearing loading yoke is attached to the near end while the far end is rigidly attached to the sliding plate. Wire resistance strain gages *1*, *2*, *3*, and *4* are cemented to both sides of both of the beams. Two pair of dummy gages cemented to similar material are attached nearby for temperature compensation.

The bridge connections shown in the wiring diagram, Fig. 5, permit the separate determination of the vertical and horizontal forces on the loading yoke. Gages Nos. *1*, *2*, *3* and *4* are active. Numbers *5*, *6*, *7* and *8* are dummy gages. The potential supplied by the battery *A* can be placed across either bridge. The two variable resistances labeled *B* are used to adjust the potential and thereby control independently the sensitivity

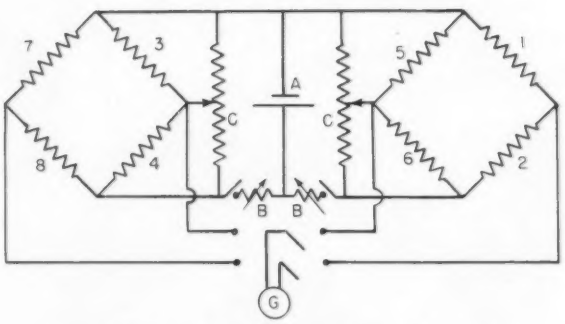


Fig. 5.—Wiring Diagram of Detecting Elements.

of either bridge. The two potentiometers *C* are used for the zero adjustments. The galvanometer *G* can be used to determine the unbalance of either bridge by means of a double throw double pole switch.

By using a direct current bridge system such as this the expense of signal generators and amplifiers is avoided. The desired sensitivity can be achieved by proper design of the beams to which the gages are attached with due consideration being given to the magnitudes of the forces to be measured.

The linearity of the load detecting systems was checked by means of dead weights, and the calibration of the galvanometer readings in terms of grams determined. Once these two points have been established it is only necessary to zero the galvanometer and set the sensitivity by means of one calibrating weight prior to testing each specimen.

The test procedure is as follows. The specimen is mounted in the chuck and the thermostat heated to the desired test temperature. Once thermal equilibrium has been established, the drive mechanism is set for the desired frequency and the test begun. Common practice has been to test at the lowest frequency of interest and to increase the frequency by two or three steps per decade. The lower frequency is limited only by the patience of the operator. The upper frequency depends on the critical speed of the specimen shaft. This, of course, is dependent on the modulus of the material being tested which will change with frequency. It should be borne in mind when estimating critical speeds that under the test conditions the specimen is a simple beam, not a cantilever as in the case of the constant stress type apparatus, since the force detecting device supports the other end.

Once the desired frequency is reached the load detecting device is pushed sideways so that the specimen is deflected by the loading yoke. The amount of deflection is preset by the micrometer stop. The horizontal component of force exerted by the specimen is then read on the galvanometer scale. In order to determine the vertical component of force the other bridge is activated and a similar procedure followed. To eliminate the need for determination of a zero on the vertical scale and to in-

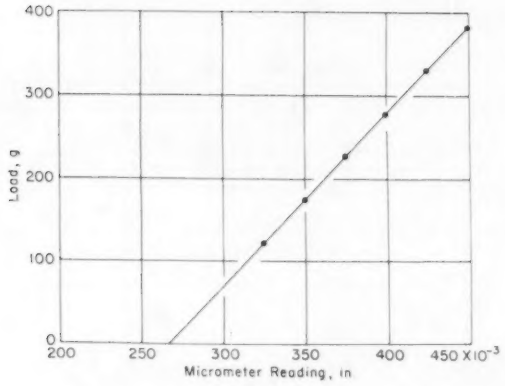


**Fig. 6.—Experimental Verification of the Linearity of Response of Detecting Device.**

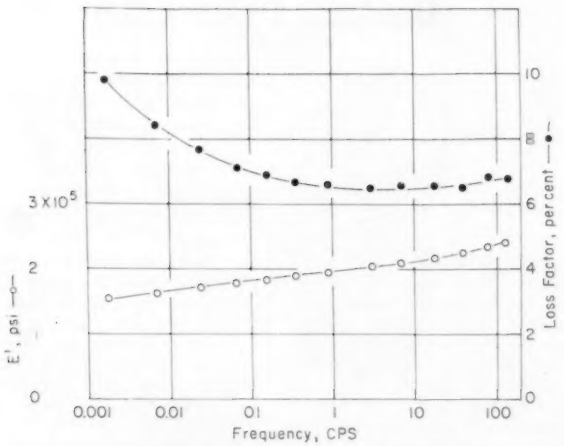


**Fig. 7.—Modulus and Loss Factor of Cellulose Acetate at 30 C.**

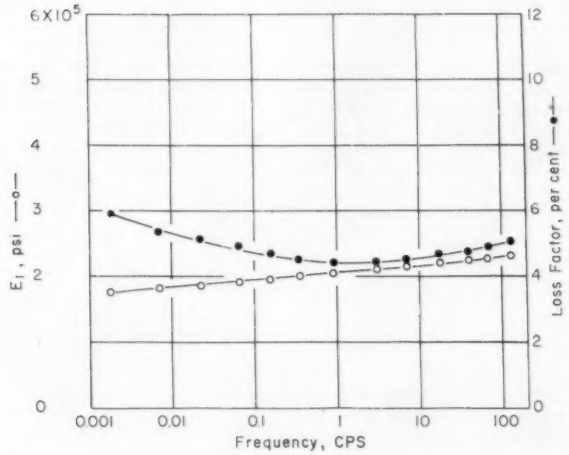


**Fig. 8.—Modulus and Loss Factor of Cellulose Acetate-Butyrate at 30 C.**

crease sensitivity, a second determination of the vertical force using the opposite direction of rotation for the specimen is made. The vertical component is then half the difference between these two galvanometer readings.

## Results

Figure 6 shows the results of a test performed to verify the linearity of response of the equipment and the specimen. Various horizontal forces required to deflect a specimen of polystyrene were determined at room temperature. The frequency used was 50 cps. The plot of micrometer reading which is proportional to deflection of the free end *versus* the horizontal load measured gives a straight line. If either the response of the material or the equipment were not linear this result would not be obtained.

Figures 7 and 8 demonstrate the response of typical plastic materials to the dynamic test. The data for a typical cellulose acetate formulation is shown in Fig. 7 for a frequency range of $1.9 \times 10^{-3}$ to $1.5 \times 10^{2}$ cps at 30 C. As the frequency is increased, the in-phase modulus increases as would be expected. The loss factor exhibits a minimum in this frequency range, indicating that on each side of this range a natural frequency associated with the relaxation times of bond mechanisms in the material will be found.

Similar data for cellulose acetate-butyrate is shown in Fig. 8. Here again a minimum is found in the loss factor curve. It is interesting to note that the modulus *versus* frequency curves for these two materials are almost exactly the same but that the cellulose acetate-butyrate exhibits a loss factor that is only about 60 per cent of that exhibited by the cellulose acetate.

The effect of both frequency and temperature on the dynamic properties of rigid polyvinyl chloride are shown in Fig. 9. As the temperature of testing is increased, the modulus curves are shifted downward along the modulus scale but maintain the same slope with regard to the frequency scale until the test temperature is raised to some point between 70 and 80 C. At 80 C the slope shows a rapid increase. Since the value of the loss factor should be proportional to the slope of the modulus *versus* log frequency curve, it is not surprising that the loss factor is essentially independent of temperature up to some point between 70 and 80 C. At 80 C the loss factor shows a sharp increase at the lower frequencies where the slope of the modulus curve is high.

The second order transition temperature of polyvinyl chloride is considered to be approximately 75 C (11). The sharp change in the dynamic properties

between 70 and 80 C confirms this and shows that below this temperature the material exhibits a high modulus relatively independent of frequency and temperature. Above this transition the modulus and loss factor are very dependent on the frequency.

Data such as those shown in Figs. 7, 8, and 9, have several direct applications to the problems of the design engineer working with plastics. The modulus data give him information on the stiffness of the material as a function of the time scale of loading. The loss factor data give him information on the energy absorbed by the material. If he is concerned with fatigue problems in his design, he would like a low loss factor. If he desires to use plastics as shock absorbing or vibration damping components, then he wants a high loss factor.

## Conclusions

Given data demonstrate that a knowledge of the variation of elastic modulus and mechanical-loss factor with frequency and temperature is important to the understanding of the behavior of polymeric materials and their proper application. These data may be obtained over a wide frequency and temperature range by means of the constant-strain-per-cycle apparatus described.

This apparatus, which applies a sinusoidally oscillating strain to the specimen, operates on a principle that is inherently simpler than many conventional dynamic testers since the response detecting device does not need to respond at the testing frequency. The magnitude of the maximum strain applied to the specimen can be controlled, thereby making it possible to test over any desired portion of the stress-strain curve.

The data presented on cellulose acetate, cellulose acetate butyrate and polyvinyl chloride demonstrate that both the modulus and loss factor are dependent on both the frequency and temperature. Therefore, it is necessary for the proper understanding of the behavior of plastic materials to test under controlled conditions of both variables.

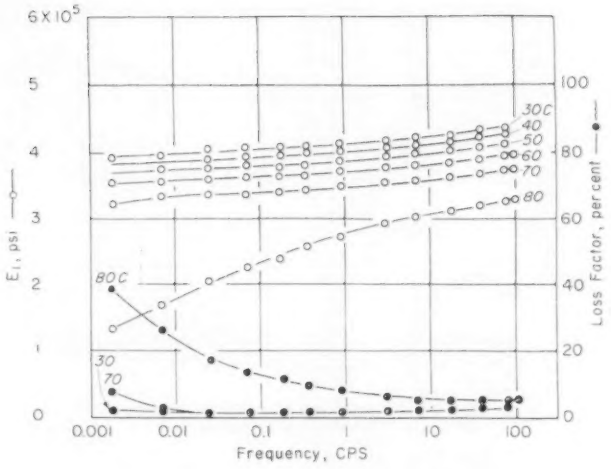


**Fig. 9.—Modulus and Loss Factor of Polyvinyl Chloride at Various Temperatures.**

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As a result of a paper by Larson and Schwaderer (5)[1] presenting a new viscosity-index scale, the Fourth World Petroleum Congress passed a resolution recommending that the subject be submitted to competent scientific institutes in various countries in order to resolve the problems encountered with the ASTM viscosity index.[2,3]

In June 1955, Technical Committee B on Lubricating Oils, and Research Division VII on Flow Properties, of ASTM Committee D-2 on Petroleum Products and Lubricants, agreed to sponsor a symposium on the subject and appointed F. I. L. Lawrence, W. Andrew Wright, and J. C. Geniesse to outline the scope and secure speakers for the meeting of Committee D-2 in Dallas on Feb. 7, 1956. Subsequent to the meeting, a special study committee was appointed by Technical Committee B and Research Division VII to study the problem and report to the sponsors.

A summary prepared by J. C. Geniesse of the symposium together with two papers presented by W. A. Wright and by E. E. Klaus and M. R. Fenske appear on the following pages.

# A Comparison of Viscosity-Index Proposals

By J. C. Geniesse

A thorough and complete analysis of the various proposals presented at the symposium would include a comparison of their scales with the present ASTM scale, the blending value of the scales, their relationship with the actual rate of change of viscosity with temperature, and so forth. Since insufficient time and data were available for such a complete analysis, the following is limited to a comparison of the scale numbers.

The Dean (1) and Davis or ASTM viscosity index (VI)[2,3] is calculated using the equation:

$$VI = 100\,\frac{L - U}{L - H} \qquad (1)$$

wherein the viscosity at 100 F for the unknown oil $U$ is compared with that of $L$, the zero VI oil, and $H$, the 100 VI oil, both defined by Dean (1) and his associates. The comparison is always made with reference oils having the same viscosity at 210 F as the unknown oil, as is illustrated in Fig. 1. It should be noted that the ratio in the equation is the numerical difference between $L$ and $U$ divided by the numerical difference between $L$ and $H$.

Figure 2 shows a plot of the ASTM constant VI lines on a chart with both scales on the same basis, namely, log log [centistokes (cs) + 0.6] which is the ordinate scale in the lubricating-oil viscosity range of the present ASTM kinematic viscosity temperature chart. The diagonal line in the lower part of the chart represents a series of hypothetical fluids having the same viscosity at 100 and 210 F. All points above this line represent fluids which decrease in viscosity as temperature is increased, whereas all points below this diagonal line represent those increasing in viscosity as temperature is increased. It can be seen that anomalous results are possible with high VI oils in that two oils with the same viscosity at 100 F and different viscosities at 210 F can have the same viscosity index.

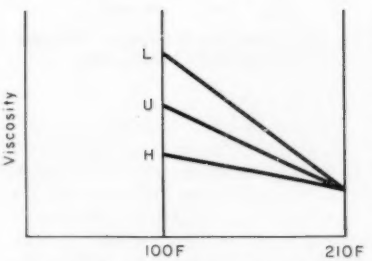


Fig. 1.—Relation of Standard and Unknown Oils for Calculating ASTM VI.

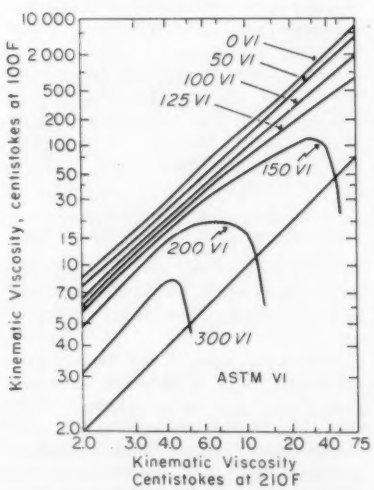


Fig. 2.—Lines of Constant ASTM VI.

In order to eliminate this deficiency, Blott and Verver (2) suggested the same type of equation but introduced the logarithm of the viscosity in place of the numerical value for viscosity:

$$\text{Viscosity modulus (VM)} = 100\,\frac{\log L' - \log U}{\log L' - \log H'} \qquad (2)$$

$L'$ and $H'$ are used in this case because Blott and Verver prefer the reference series proposed by Hersh, Fisher, and Fenske (3) rather than those sponsored by Dean and his associates. Figure 3

**J. C. GENIESSE is director of the Application Research Div., Research and Development Department of the Atlantic Refining Co. He is Chairman of Research Division VII on Flow Properties of ASTM D-2 on Petroleum Products and Lubricants. Research Division VII and its predecessor has developed and standardized the viscosity methods for Committee D-2.**

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] ASTM Viscosity Tables for Kinematic Viscosity Conversions and Viscosity Index Calculations. ASTM *STP 48A*.

[3] Method for Calculating Viscosity Index (D 567 – 53), 1955 Book of ASTM Standards.

[4] Symposium on Viscosity-Index Systems. Presentations included references 2, 5, 6, 7, 8, 9 and 10, with a comparison of the proposals (J. C. Geniesse).

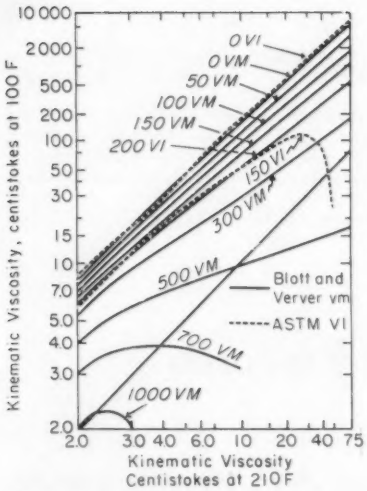


Fig. 3.—Blott and Verver Viscosity-Modulus Lines with Typical ASTM VI Lines.

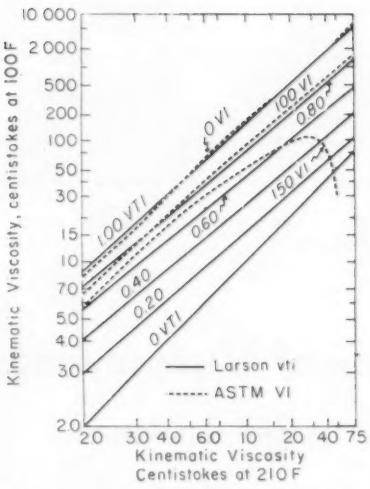


Fig. 4.—Larson and Schwaderer Viscosity-Temperature Index Lines.

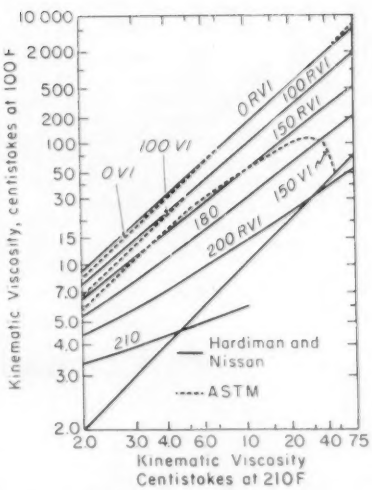


Fig. 5.—Hardiman and Nissan Rational Viscosity Index Lines.

shows the Blott and Verver viscosity-modulus curves of constant value with some typical ASTM VI curves superimposed in order to obtain a visual comparison of the two scales. It may be seen that anomalous values are not obtained with this proposal until the so-called perfect oil is approached.

Malschaert (**4**) had previously gone a step further by introducing the Walther expression, log log (cs + 0.8), which was the basis for the viscosity scale on the viscosity-temperature chart at the time his proposal was made. The present chart uses 0.6 instead of 0.8 in the lubricating-oil range. This difference is insignificant for the purposes of this discussion. Malschaert suggested the use of the Dean *H* and *L* series; consequently his equation is:

$$\text{Independent viscosity index} = 100\,\frac{\log\log(L+0.8) - \log\log(U+0.8)}{\log\log(L+0.8) - \log\log(H+0.8)} \quad \ldots\ldots(3)$$

Referring back to Fig. 1, the Malschaert method is equivalent to using the measured distances on the ASTM viscosity-temperature chart between *L* and *U*, and *L* and *H*, instead of the numerical difference between the viscosities.

Larson and Schwaderer (**5**) introduce a new concept in that they adopt a *P* series, no change of viscosity with temperature, as the ideal or lower limit on the chart which is shown as the zero viscosity-temperature index (VTI) line on Fig. 4. They also modify the *L* series to straighten it and approach that of Hersh, *et al.*, by drawing the line labeled 1.00 through the two points:

1. 29.10 cs at 100 F and 4 cs at 210 F
2. 5830 cs at 100 F and 75 cs at 210 F

In order to obtain the intermediate lines the authors spaced them on the vertical 15 cs at 210 F line directly proportional to log log (cs + 0.6). Since this is the basis for Fig. 4, the lines are spaced equally on the 15 cs at 210 F line. Next, the authors spaced the lines on the vertical 4 cs at 210 F line proportional to log (cs + 0.6). Straight lines were then drawn through the points established on the 4 cs and 15 cs lines as shown on Fig. 4.

In an alternate proposal Larson and Schwaderer again use the *P* or 0 VTI line as the lower line but adopt a straightened Dean and Davis *H* for the upper line. This line, called 1.00 VTI, is drawn through:

1. 20.59 cs at 100 F and 4.0 cs at 210 F
2. 1925 cs at 100 F and 75.0 cs at 210 F

In this case the lines are spaced equally on the chart which would be equivalent to proportioning them to log log (cs + 0.6).

The calculation of the Larson and Schwaderer VTI is involved; however, that should not be a deterrent since tables can be prepared such as now used for viscosity index. Their proposals eliminate the anomalous results obtained with the ASTM VI scale at high values.

Hardiman and Nissan (**6**) propose the rational viscosity index (RVI) based on the equation

$$V_{100} = K(V_{210})^n \quad \ldots\ldots(4)$$

in which *K* is a constant for all VI series and *n* is a characteristic of the oil. On the assumption that $K = 2.714$ and solving for *n* in

$$n = \frac{\log V_{100} - 0.4336}{\log V_{210}}$$

gives an *n* of 1.51 for a 100 VI oil and 1.78 for a zero VI oil. In order to make a scale similar to the VI scale, the authors plotted *n* against viscosity index over the VI range 0 to 100 and find this equation to fit that range:

$$\text{RVI} = (60.0 - \text{antilog } n) \times 3.63 \quad \ldots\ldots(5)$$

However, the extension of this equation to higher RVI and low viscosity values introduces uncertainties as is quite evident in Fig. 5. The Hardiman and Nissan scale corresponds to the VI scale quite closely at high viscosities but diverges at lower values.

In a similar treatment, Wright (**7**) starts with the equation:

$$(V_{210})^m = \frac{V_{100}}{AV_{210}} \quad \ldots\ldots(6)$$

where the exponent *m* is the characterizing factor called viscosity-temperature function (VTF). Solving for *m* results in the following equation:

$$\text{VTF} = m = \frac{\log V_{100} - 0.3522}{\log V_{210}} - 1 \quad \ldots(7)$$

Figure 6 shows the plot and, as is evident the curves are similar to those of Hardiman and Nissan.

Klaus and Fenske (**8**) describe the ASTM slope, which is the tangent of the angle between the viscosity-temperature line and constant viscosity lines on the ASTM kinematic viscosity-temperature chart. As shown in Fig. 7, it is obtained by dividing the linear distances *Y* by *X*.

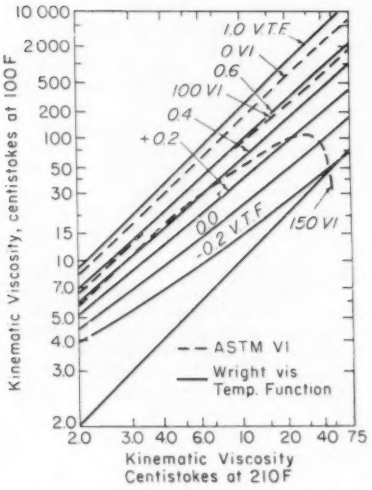


Fig. 6.—Wright Viscosity-Temperature Function Lines.

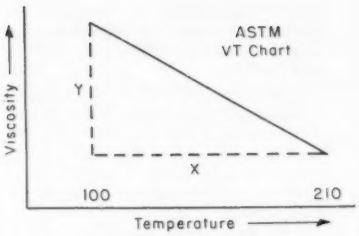


Fig. 7.—Construction for Measuring ASTM Slope from ASTM Kinematic Viscosity-Temperature Chart.

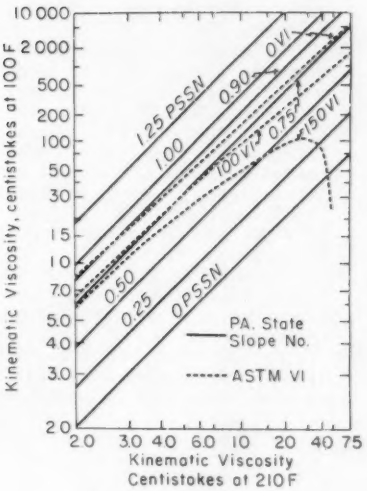


Fig. 8.—Pennsylvania State Slope Number Lines.

On Fig. 8 the ASTM slope, sometimes called the Pennsylvania State slope number, is compared with the ASTM viscosity index. It may be seen there are no ambiguities such as exist with the ASTM viscosity index; also the zero line is that for fluids which do not change in viscosity with temperature. The scale is in the reverse order to that presently used by industry in that the high numbers are for oils which decrease more rapidly when temperature is increased.

Ramser's (**9**) proposal, called viscosity-temperature rating (VTR), was conceived with the aim of using a more fundamental basis for expressing viscosity-temperature slope. He reasons that the average percentage change in viscosity with temperature is more logical and may be expressed as:

$$100\,\frac{2.3026}{t_1 - t_2}\log\frac{V_1}{V_2} \qquad (8)$$

then multiplying by $-100$ to remove the negative sign and obtain whole numbers,

$$\text{VTR} = \frac{23026}{t_2 - t_1}\log\frac{V_1}{V_2} \qquad (9)$$

Figure 9 shows a plot of constant VTR values for 100 to 210 F temperature range in comparison with ASTM viscosity index. In this case also there is no ambiguity in the scale. This scale is also the reverse of that commonly used. Again the lowest or zero VTR line corresponds to a series of fluids which do not change with temperature.

The Cornelissen and Waterman (**10**) proposal is similar to that of Ramser. It is called the fundamental viscosity temperature index (FVTI), and is calculated using the following equation:

$$\text{FVTI} = \log\frac{V_1}{V_2} \qquad (10)$$

For a given temperature range these values differ from that of Ramser by a multiplying constant. In case the 100 to 210 F range is considered, Ramser's values are 209 times as large as those of Waterman. Figure 10 shows constant FVTI lines calculated from viscosities at 100 and 210 F. All comments that apply to Ramser's concept are equally significant here. Obviously neither case is limited to the 100 and 210 F temperature range but, if other ranges are used, separate tables would have to be prepared to avoid making the individual calculations.

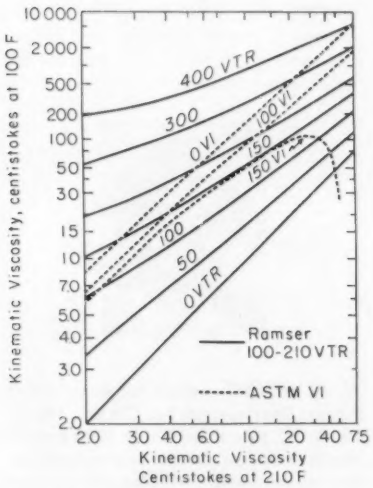


Fig. 9.—Ramser Viscosity-Temperature Rating Lines.

## Conclusion

It is obvious to everyone concerned that proposals are not in short supply. The symposium has included a few of the more interesting types. There are many more in the literature. A thorough analysis will require a very careful study and evaluation of their merits in the light of their eventual use.

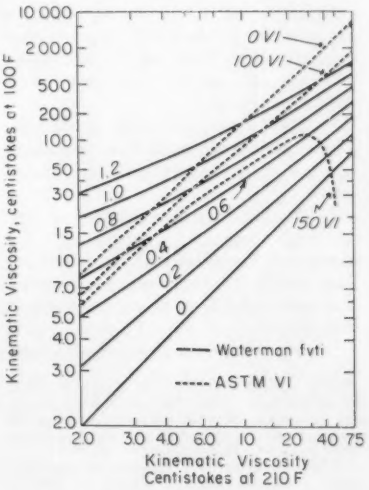


Fig. 10.—Cornelissen and Waterman Fundamental Viscosity Temperature Index Lines.

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# The Viscosity-Temperature Function*


By W. A. Wright


THE undesirable features of the present viscosity-index (VI) classification have been pointed out by various authors (**1–4**)[1] and it is not necessary to repeat them at this time. When examining the possibility of supplanting the viscosity index by a more suitable expression, we should carefully consider the requirements which any new system should meet.

These requirements may be stated as follows:

1. The desired expression should be a single number which is constant for a whole series of different viscosity oils from the same crude oil. No auxiliary reference to actual viscosity level should be necessary.

2. The number should be directly related to fundamental flow properties and not dependent on arbitrary standards.

3. It should be independent of any empirical equation expressing the change of viscosity with temperature. This would avoid future invalidation if a new viscosity-temperature relation is developed.

4. The single numbers should bear a fairly good relation to chemical constitution in the case of petroleum oils.

5. Specialized data or tables should not be required, although such tables could be used as a matter of convenience.

6. The required number should be obtained by a rapid and simple calculation.

These conditions might appear rather idealized. It is the purpose of this discussion, however, to outline a method which readily meets these requirements.

## Mathematical Relations

The derivation of the viscosity-temperature function (VTF) is given in the Appendix. The relationships only will be outlined at this time. The mean heat of activation for flow ($\Delta H^{\pm}$) over a temperature range of 100 to 210 F (**5**) is given in Eq 1.

$$\Delta H^{\pm}_{12} = C \log \frac{\mu_1}{\mu_2} \quad \ldots\ldots (1)$$

where:

$\mu_1$ = kinematic viscosity, in centistokes (cs) at 100 F,

$\mu_2$ = kinematic viscosity, in centistokes at 210 F

$C$ = constant

It can also be shown (see Appendix) that the molecular weight of an oil is a logarithmic function of $\mu_1$ and $\mu_2$. It is demonstrated in the Appendix that for any homologous or related series of oils:

$$A\mu_2^m = \frac{\mu_1}{\mu_2} \quad \ldots\ldots (2)$$

where:

$m$ = a constant characteristic of the oil, and

$A$ = constant (approximately equal to 2.25).

Combining the above Eqs 1 and 2, and writing in logarithmic form, we find that:

$$m \log \mu_2 = \frac{\Delta H^{\pm}_{12}}{C} - \log A = \log \frac{\mu_1}{A\mu_2} \quad \ldots\ldots (3)$$

Examination of Eq 3 will disclose that, at constant $\mu_2$, $m$ and $\Delta H^{\pm}$ are functions of composition and molecular weight. At constant $m$, $\Delta H^{\pm}$ is a function of molecular weight only.

**W. A. WRIGHT, assistant to the manager of Product Development, Sun Oil Co., Marcus Hook, Pa., joined Sun Oil in 1936 and has specialized in the development and application of lubricants. Rheological problems and theories have been a particular interest for a number of years.**



**NOTE.**—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Symposium on Viscosity-Index Systems, sponsored by ASTM Committee D-2 on Petroleum Products and Lubricants, Dallas, Tex., Feb. 7, 1956.


[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

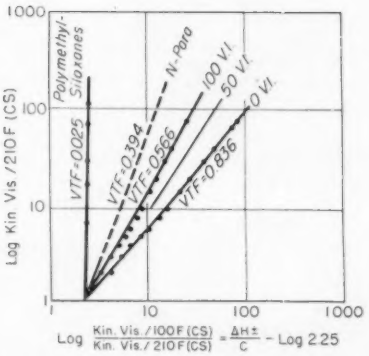


**Fig. 1.—Viscosity-Temperature Function of Lubricants.**

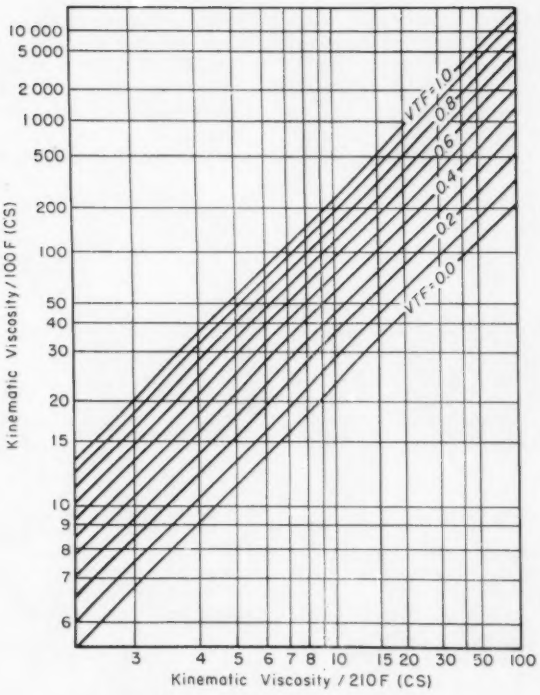


**Fig. 2.—Viscosity-Temperature Function Chart.**

The function $m$ is obviously a characterizing expression which meets the requirements originally listed, and is dependent on fundamental properties only. It is suggested that $m$ be called the viscosity-temperature function (VTF).

### Application of VTF to Known Substances

Figure 1 illustrates the application of actual data to Eq 2. The ratio of the kinematic viscosities at 100 and 210 F are plotted against the viscosity at 210 F. The slope (or tangent of the angle) between the resulting straight lines and the kinematic viscosity scale at 210 F is the function $m$ (or VTF). Except for the irregularities at the lower viscosities (due to the known irregularities in the present VI classification) the lines are straight. This linear relationship is strictly true for the *n*-paraffins up through the presently available data ($C_{20}H_{42}$). Various other series such as polybutenes, and polymethyl siloxanes also plot as straight lines. It seems obvious, as has been suggested by others, that we should eliminate the irregularities in the VI system and adopt the straight line as a standard. On this basis, we can visualize the scale of the VTF by the following:

| | Viscosity-Temperature Function |
|---|---|
| 0 VI oils | 0.836 |
| 100 VI oils | 0.566 |
| *n*-Paraffins | 0.394 |
| Polymethyl siloxanes | 0.025 |

The roughly 300 units separating the 0 and 100 VI oils are ample for practical use.

The rather surprising fact that all of these lines appear to converge at $\mu_1 = 2.25$ cs and $\mu_2 = 1$ cs is difficult to explain fully. Normal paraffins do pass through this point in the region of $C_{14}H_{30}$. Other pure hydrocarbons do not quite meet at this point. Since it is so far from the range of lubricant molecular weights, it does not seem to be of serious import. Since $A = 2.25$, Eq 2 thus becomes:

$$\mu_2^m = \frac{\mu_1}{2.25\,\mu_2}$$

The VTF relation has been found to hold for a wide variety of petroleum oils. It has been applied to some oils used in the Harvard project on the viscosity of oils under high pressure, sponsored by the ASME (6). Distillation fractions of Webster crude oil prepared for constitutional analysis were found to fit well. Subsequently, these fractions were further separated by silica gel and finally hydrogenated. The VTF reliably classified all of these various series according to type. Commercial fractions from refinery operations have been found to be properly classified by the VTF.

While convenient tables or nomographs of VTF and viscosity at 100 and 210 F can be prepared, they are not necessary. Only two settings on a log-log slide rule will give the VTF directly in little more time than by using tables. Figure 2 is a convenient chart for finding the VTF values of oils.

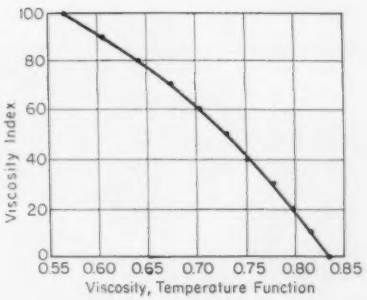


**Fig. 3.—Approximate Relation of Viscosity-Temperature Function *Versus* Viscosity Index.**

### General Comments

Examination of the VTF will readily show that it meets the idealized requirements originally set forth. In this respect, it exceeds the ability of any other proposed function to the best of the author's knowledge. It is interesting to observe that, in so doing, it encompasses the features (and even the same expression in the case of Ramser's viscosity-temperature ratio (2)) of the other systems. The recent proposal by Larson and Schwaderer (4), while based on arbitrary standards,

can be mathematically related to VTF. The relation between the VTF and the VI classification is quite simple. This is illustrated in Fig. 3. The approximate VI values given here ignore the irregularities in the present VI classification. Figure 3 indicates that the conversion from viscosity index to VTF would not lead to excessive confusion. It is felt that the VTF is a logical replacement for viscosity index and will avoid the difficulties now existing in the latter system.

The discussion of VTF given here has been considerably condensed for the purpose of the ASTM Symposium on Viscosity-Index Systems.

The Appendix, which was not previously presented, has been added for those who are interested in the mathematical relationships involved.

---

## APPENDIX

## DERIVATIONS OF RELATIONSHIPS IN THE VISCOSITY-TEMPERATURE FUNCTION

We have, from the concept of viscous flow as a rate process (7)

$$\eta = \frac{hN}{V} e^{\Delta F^{\pm}/RT} \quad \ldots\ldots (4)$$

where:

$\eta$ = absolute viscosity,
$h$ = Plank's constant,
$N$ = Avogadro's number,
$\Delta F^{\pm}$ = free energy of activation per mole, $\Delta H^{\pm} - T\Delta S^{\pm}$,
$R$ = gas constant, and
$T$ = absolute temperature.

Therefore,

$$\eta = \left(\frac{hN}{V} e^{-\Delta S^{\pm}/R}\right) e^{\Delta H^{\pm}/RT} \quad \ldots (5)$$

Although it has nothing to do with the derivations of the VTF, it is interesting to note that, if the volume does not change rapidly with temperature and $\Delta S^{\pm}$ is assumed constant,

$$\eta = Ae^{\Delta H^{\pm}/RT}$$

which is the Arrhenius equation.

Equation 4 can be rearranged to give:

$$\Delta F^{\pm} = RT \ln \frac{V\eta}{hN}$$

For density ($d$), $V = MW/d$, $\eta/d = \mu$ = kinematic viscosity, and MW = molecular weight.

Consequently,

$$\frac{\Delta F^{\pm}}{RT} = \ln \frac{MW\mu}{hN} = \frac{\Delta H^{\pm}}{RT} - \frac{\Delta S^{\pm}}{R} \quad \ldots (6)$$

or,

$$e^{\Delta H^{\pm}/RT} = \frac{MW\mu}{hNe^{-\Delta S^{\pm}/R}} \quad \ldots\ldots (7)$$

The actual magnitude of $\Delta S^{\pm}$, its dependence on temperature or molecular weight, or the validity of including Plank's constant, may be open to question. For any oil, however, the relative values in the above expression are not changed by these considerations.

Then,

$$\frac{\Delta H^{\pm}}{RT} = \ln \frac{MW\mu}{hNe^{-\Delta S^{\pm}/R}} \quad \ldots\ldots (8)$$

Equation 7 is equivalent to Eq 5, except that Eq 7 is expressed in terms of kinematic viscosity.

Equation 7 can be written as:

$$\left(\frac{MW\mu}{hNe^{-\Delta S^{\pm}/R}}\right)^{\frac{RT}{\Delta H^{\pm}}} = e \quad \ldots\ldots (9)$$

Over the temperature range of $T_1$ and $T_2$, with kinematic viscosities $\mu_1$ and $\mu_2$, MW is constant for any single oil. Assuming $\Delta S$ is constant, we can determine the mean heat of activation for flow ($\Delta H^{\pm}{}_{12}$), for a given oil, as:

$$\Delta H^{\pm}{}_{12} = R \frac{d(\ln)\mu}{d^1/T}$$

or,

$$\frac{\Delta H^{\pm}{}_{12}}{RT_{12}} = \ln \frac{\mu_1}{\mu_2} = 2.302 \log \frac{\mu_1}{\mu_2}$$

Since this holds for any oil,

$$\left(\frac{\mu_1}{\mu_2}\right)^{\frac{RT_{12}}{\Delta H^{\pm}{}_{12}}} = e \quad \ldots\ldots (10)$$

We can now equate Eqs 9 and 10 to evaluate $\mu_1/\mu_2$ in terms of $\mu_2$:

$$\left(\frac{\mu_1}{\mu_2}\right)^{\frac{RT_{12}}{\Delta H^{\pm}{}_{12}}} = \left(\frac{MW\mu_2}{hNe^{-\Delta S^{\pm}{}_2/R}}\right)^{\frac{RT_2}{\Delta H^{\pm}{}_2}} \quad \ldots (11)$$

Hence,

$$\frac{\mu_1}{\mu_2} = \left(\frac{MW}{hNe^{-\Delta S^{\pm}{}_2/R}}\right)^{\frac{RT_2}{\Delta H^{\pm}{}_2} \cdot \frac{\Delta H^{\pm}{}_{12}}{RT_{12}}} \mu_2^{\frac{RT_2}{\Delta H^{\pm}{}_2} \cdot \frac{\Delta H^{\pm}{}_{12}}{RT_{12}}} \quad \ldots (12)$$

Examination of Eq 12 suggests that as the molecular weight increases in any given oil series, $(RT_2/\Delta H^{\pm}{}_2) \bullet (\Delta H^{\pm}{}_{12}/RT_{12})$ remains constant, since $RT_2/\Delta H^{\pm}{}_2$ will decrease as $\Delta H^{\pm}{}_{12}/RT_{12}$ increases. A plot of $\mu_1/\mu_2$ *versus* $\mu_2$ for normal paraffins on log log paper shows this to be true by giving a straight line. The equation of this line is found to be:

$$2.25\ \mu_2{}^{2.390} = \frac{\mu_1}{\mu_2}$$

where $\mu_1$ and $\mu_2$ are the kinematic viscosities at 100 and 210 F. Similar plots of other series of oils known to be constitutionally related (similar carbon-type composition in the case of petroleum oils) also give straight lines. It is interesting that, in each case, these series all seem to extrapolate to the same constant (2.25), for all practical purposes.

We can then conclude that any related series of oils can be expressed as:

$$2.25\ \mu_2{}^m = \frac{\mu_1}{\mu_2} \quad \ldots\ldots (13)$$

(for the range of 100 to 210 F)
This has the equivalent form

$$2.25\ \mu_2{}^{m+1} = \mu_1 \quad \ldots\ldots (14)$$

$m$ is a characterizing constant which has been labeled the viscosity-temperature function.

Comparing Eqs 12, 13, and 14, it is apparent that plotting log $\mu_1$ *versus* log $\mu_2$ should give straight lines of isomolecular weight. This has been found to hold for petroleum oils over a wide range of constitution, and publication is intended at a later date.

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# The Use of ASTM Slope for Predicting Viscosities*

By E. E. Klaus and M. R. Fenske

**ASTM slope and viscosity index are compared with percentage change of viscosity with temperature, and the advantages and shortcomings of ASTM slope are discussed. Methods are presented for measuring kinematic viscosities over the range of 700 to −65 F with data showing limitations of the ASTM viscosity-temperature chart over this range. The fluids studied were mineral oils, esters of organic and inorganic acids, and polymer-containing oils. The errors obtained by using ASTM slope and the ASTM viscosity-temperature chart to obtain viscosities by interpolation and extrapolation, and methods for eliminating them are given. The authors recommend use of measured viscosities at the temperature extremes encountered in a specific application.**

MINERAL oil and synthetic hydraulic fluids and lubricants with viscosity indexes (VI) above 150 have been used extensively by the armed forces for the past 14 yr. More recently fluids with similar viscosity indexes are being used as hydraulic transmission fluids and multiple-grade crankcase oils in the automotive field. Experience with the former application has shown the desirability of employing measured viscosities at the temperature extremes encountered in a specific application as well as using a meaningful expression for the viscosity-temperature coefficient. Both of these approaches (that is, measured viscosities and a useful viscosity-temperature characteristic) are applicable to the automotive field.

Many methods of expressing the viscosity-temperature characteristics of lubricants have been proposed. The ASTM slope, which expresses viscosity-temperature characteristics, is discussed here to show its utility and limitations.

## ASTM Slope

This value is based on the ASTM viscosity-temperature chart which was adopted in 1932. The viscosity index as originally proposed by Davis and Dean (**1, 2**)[1] was already established as a measure of an oil's viscosity-temperature characteristics at the time of adoption of the ASTM chart.

The ASTM chart is based on an equation developed by Walther (**3–6**) in a series of papers. The form of the equation used can be represented as follows:

$$\text{Log log } (v + k) = \log B - A \log T \quad \ldots\ldots(1)$$

or

$$\text{Log } (v + k) = \frac{B}{T^A} \quad \ldots\ldots(2)$$

where:

- $v$ = kinematic viscosity in centistokes,
- $k$ = constant (0.6 for viscosities exceeding 1.5 centistokes),
- $T$ = absolute temperature, deg Rankine (459.69 + $t$ F), and
- $A$ and $B$ = constants for a particular oil.

This equation is empirical and has not yet been derived precisely from any physical properties of liquids. The viscosity of a large majority of hydrocarbons and mineral oils can be portrayed as straight lines on this ASTM chart.

Several methods of expressing slope on an ASTM chart have been proposed. Umstätter (**7**) suggested that a slope of the viscosity-temperature line based on Walther's equation be used to characterize lubricants:

$$\text{Slope} = \frac{\log \log (v_1/v_2)}{\log (T_2/T_1)} \quad \ldots\ldots(3)$$

Bell and Sharp (**8**), used a different method of expressing the slope of lines on the ASTM chart. In their system, two arbitrary linear scales are superimposed on the ordinate and abscissa of the ASTM chart, and the slopes are evaluated in terms of these new scales. The range of 0 to 100 VI corresponds to 310 to 220 on this slope scale.

Clayden (**9**) proposed still another method based on the slope of the line on an ASTM viscosity-temperature chart. His method consists of drawing a straight line on the ASTM chart through 10,000 centistokes at 0 C and parallel to the viscosity-temperature line of the test liquid. The intersection of this line with 100 C is equivalent to a viscosity which is used to characterize the fluid. The range of 0 to 100 VI corresponds to 10 to 40 using this system.

The method used here has been developed to obtain maximum significance and simplicity of determination (**10**).

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

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Data appearing in this paper are based on work done at the Petroleum Refining Laboratory, The Pennsylvania State University.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

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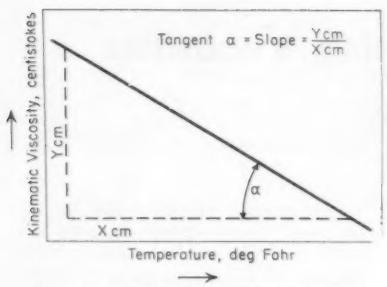


**Fig. 1.—Method of Calculating ASTM Slope.**

ature line of the test fluid on the ASTM chart. The reference point is placed on any horizontal (constant viscosity) line. The slope is read from the point of intersection of this same horizontal line with the graduated edge of the protractor. The slope protractor is prepared by substituting the value for the tangent of the angle for the angle in degrees and minutes on a standard protractor scale. The graduations are based on the reference point and, therefore, the line of zero slope is that line passing through the reference point and parallel to the straightedge indicated by the arrows.

A table has been prepared by Eby (**11**) for the determination of ASTM slope to an accuracy of 0.001 unit. Slopes can be obtained from this table by subtracting the slope scale value equivalent to the 210 F viscosity from the corresponding slope scale value equivalent to the 100 F viscosity. By relatively simple calculations, the ASTM slopes for any other desired temperature interval can be obtained from this slope table and a corresponding table relating temperatures. ASTM slope is easily used over wider temperature intervals than 100 and 210 F. This is probably not true of many other schemes for describing the viscosity-temperature properties of oils.

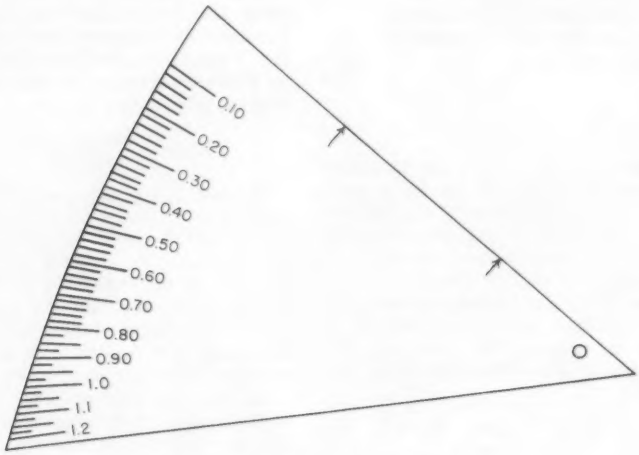


**Fig. 2.—ASTM Slope Protractor.**

### Comparison of Viscosity Index and ASTM Slope

A comparison of ASTM viscosity index and ASTM slope as a function of viscosity level is shown in Fig. 3. The ASTM slope shows a general decrease for a constant viscosity index with increasing viscosity level. The relationship between ASTM slope and viscosity index shows the widest variation for high-viscosity-index oils (150 to 200 VI). It is in this viscosity-index range that many new types of hydraulic fluids and lubricants fall.

The calculation of this ASTM slope is shown in Fig. 1. The viscosity-temperature line makes an angle $\alpha$ with the lines of constant viscosity. The tangent of $\alpha$ is the slope of the centistoke viscosity-temperature line, or it is the linear distance $Y$ divided by the linear distance $X$.

$$\tan \alpha = \text{slope} = \frac{Y}{X} \text{ cm} \quad \ldots\ldots (4)$$

The slope values are all negative. The minus sign has been omitted in all slope values given in this paper. The range in ASTM slope for oils from 0 to 100 VI of 100 centistokes at 100 F is 0.863 to 0.704.

The ASTM slope is easily determined. Values accurate to within 0.01 slope unit can be obtained by an ASTM chart and a simple ruler to measure the distances $X$ and $Y$.

Similar accuracy can be obtained with the slope protractor (**10**) shown in Fig. 2. This instrument is used by placing the straightedge indicated by the arrows along the viscosity-temper-

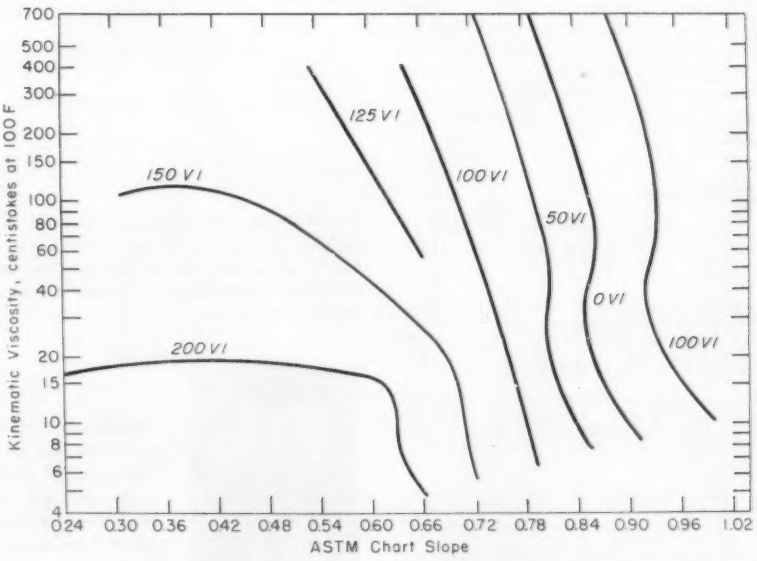


**Fig. 3.—Comparison of ASTM Slope and ASTM Viscosity Index.**

The relative merit of ASTM slope and viscosity index can best be illustrated by the use of a third method of expressing viscosity-temperature properties. The percentage change in viscosity per unit change in temperature has been chosen for this illustration.

The equation for determining per cent viscosity change per degree Fahrenheit, which can be derived (**12**) from the general equation for the ASTM chart, is given below:

$$100\left(\frac{\Delta v}{v\Delta t}\right)_t = -230.2585\,\frac{(v+k)\log(v+k)}{vT}\left[\frac{\log\log(v_1+k)-\log\log(v_2+k)}{\log T_2-\log T_1}\right] \quad \ldots(5)$$

The percentage change of viscosity per unit change in temperature is a property that can be measured directly. It is also a simple and informative property. The above equation shows that the per cent change in viscosity per degree Fahrenheit varies with viscosity level, temperature level, and viscosity-temperature characteristics of the fluid. The variation with both temperature and viscosity limits the use of this concept for expressing viscosity-temperature characteristics.

A comparison of viscosity index with per cent change in viscosity per unit of temperature at 100 F is shown in Fig. 4 as a function of viscosity level. These data emphasize the lack of significance of high-viscosity-index values in terms of rate of change of viscosity with temperature. Over the range of −100 to +100 VI the comparison of viscosity index with percentage change in viscosity per degree Fahrenheit appears to be a regular function of viscosity level. If the temperature level of this comparison is raised from 100 to 210 F, the curve for 100 VI oils begins to be of the same type as the 150 VI oil compared at 100 F.

A comparison of ASTM slope with per cent change in viscosity per unit temperature at 100 F is shown in Fig. 5. These data indicate that ASTM slope is a regular function of viscosity level and per cent change in viscosity over the entire range of slope values studied. The shapes of the curves are not substantially altered by presenting the comparison at 210 F rather than 100 F. At the higher temperature, the position of the curves is displaced somewhat to the left because of the effect of temperature increase on lowering the rate of change of viscosity with temperature for the same viscosity level.

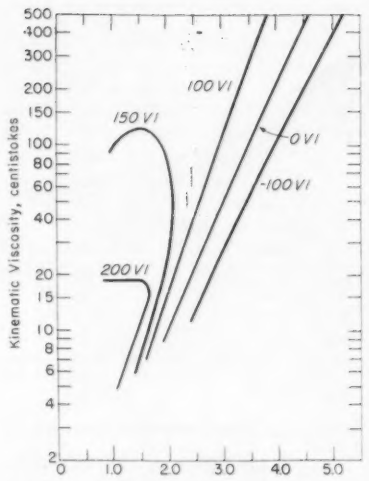


Fig. 4.—Comparison of ASTM Viscosity Index and Rate of Change in Viscosity with Temperature at 100 F.

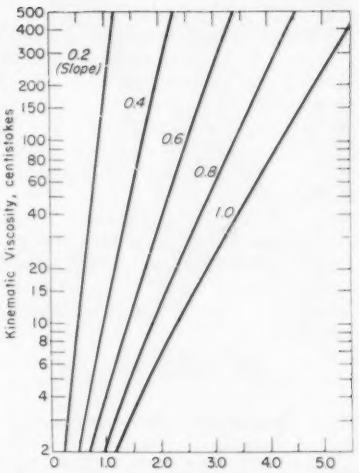


Fig. 5.—Comparison of ASTM Slope and Rate of Change in Viscosity with Temperature at 100 F.

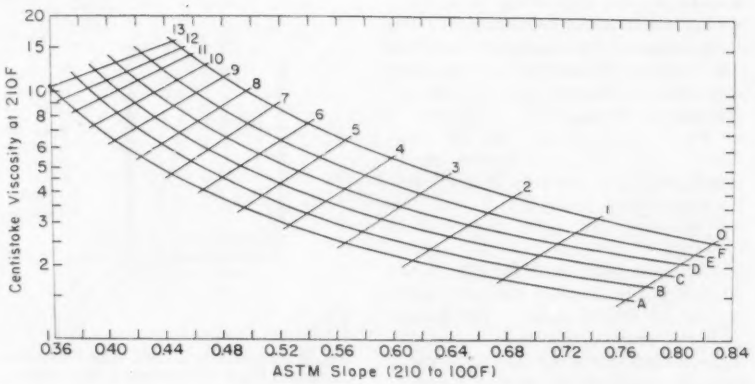


Fig. 6.—Use of ASTM Slope in a Blending Chart for Polymethacrylate AC 58 in Mineral Oils.

NOTE.—Numbers indicate per cent polymer concentration; lines adjacent to numbers indicate constant polymer concentration. Letters indicate base-stock properties; base stocks *B*, *C*, *D*, and *E* prepared by blending mineral oils *A* and *F*.

## Use of ASTM Slope in Polymer Blending

Linear-type polymeric thickeners are widely used in mineral-oil base stocks to formulate high-viscosity-index hydraulic fluids and lubricants. From a relatively small number of experimental blends, the properties of a wide range of fluids formulated from a given type of base stock and polymeric additive can be characterized.

The polymethacrylates designated as AC-58 and AC-25 are oil-soluble high-molecular-weight esters typical of those in current commercial use as viscosity-index improvers for mineral oils. The numerals 58 and 25 designate their relative thickening power at the same concentration.

A typical family of six curves illustrating the use of ASTM slope in this characterization is shown in Fig. 6. These curves are for blends of a polymethacrylate additive in a series of low-pour-point light oils. Specification 51-F-21 Navy hydraulic gear oil and Specification MIL-O-5606 aircraft hydraulic fluid are prepared from this type of material.

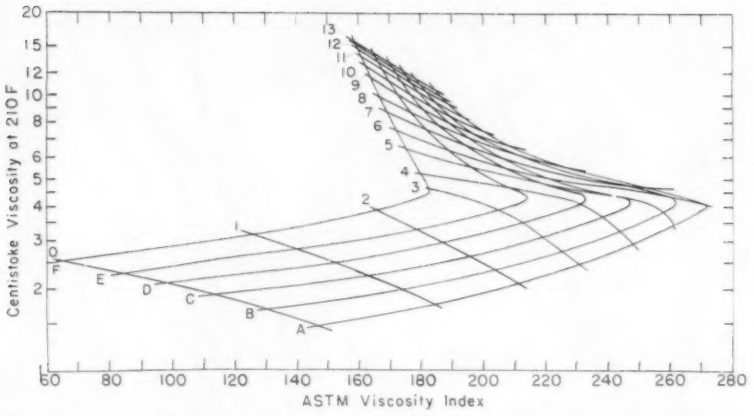


**Fig. 7.—Use of ASTM Viscosity Index in a Blending Chart for Polymethacrylate AC 58 in Mineral Oils.**

NOTE.—Numbers indicate per cent polymer concentration; lines adjacent to numbers indicate constant polymer concentration. Letters indicate base-stock properties; base stocks *B*, *C*, *D*, and *E* prepared by blending mineral oils *A* and *F*.

As mentioned, six base oils are shown. The four intermediate base oils are blends of a light oil and a heavier oil. The ASTM slopes of the intermediate blends indicate that slope is approximately additive for such blends. The lines indicated by numbers from 1 to 12 are lines of constant polymer concentration in the various base stocks. Because of the regularity of the curves in Fig. 6, interpolation can be accurately made. The same general curves result from the viscosity at any temperature other than 210 F and the ASTM slope for other temperature intervals.

The same data used for Fig. 6 are plotted in Fig. 7 using viscosity index instead of ASTM slope. The curves in Fig. 7 show erratic behavior at the high-viscosity-index levels of the same type previously shown in Figs. 3 and 4.

### Measurement of Viscosity at Temperature Extremes

To determine the limitations of any scheme for expressing viscosity-temperature coefficient, it is necessary to measure viscosities at the temperature extremes. Viscosity-temperature relationships are usually expressed for the temperature interval of 210 to 100 F. A comparison of the viscosity-temperature behavior of several fluids is only valid if all of the fluids conform to the same viscosity-temperature relationship over the entire temperature range encountered in use. The viscosity-temperature behavior of many nonadditive mineral oils can be portrayed by essentially a straight line on the ASTM chart over the range of about 500 F down to approximately the cloud point.

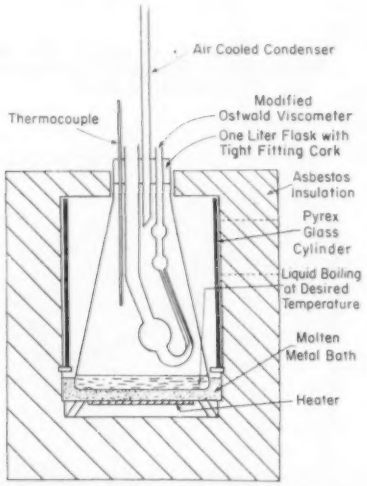


**Fig. 8.—Apparatus Used in the Determination of High-Temperature Viscosities.**

Synthetics and polymer-containing mineral oils do not necessarily conform to the ASTM viscosity-temperature chart over this wide a temperature interval. To illustrate this lack of conformance, it is first necessary to measure viscosities over a wide temperature interval. This laboratory has been determining viscosities at both high and low temperatures for the past 15 yr. These determinations have been made with the modified Ostwald viscometer specified in ASTM test method D 445 – 53 T[2] over a temperature range of +700 to −65 F. The only difference between viscosity techniques at the temperature extremes and those at 100 F is the type of temperature bath, and temperature control and measurement.

Viscosity measurements at 300 to 700 F have been made in a vapor bath of the type shown in Fig. 8. Here constant temperature is achieved by a boiling liquid. The heat is applied directly to a molten-metal bath which in turn supplies the heat to boil the liquid hydrocarbon in the vapor bath. Hydrocarbons are chosen for the vapor bath to give approximately the desired temperature. For example, biphenyl gives a vapor bath temperature of 490 F, and *m*-terephenyl a temperature of 707 F. The vapor temperature is measured by means of a thermocouple, and the viscosity is reported at this temperature. This technique has been successfully used as a reproducible routine test procedure for high-temperature viscosity determinations.

Low-temperature viscosities (+32 to −65 F) are obtained in conventional modified Ostwalt viscometers in the apparatus shown in Fig. 9. The bath here consists of a one-gallon Dewar flask of acetone. The bath is cooled

[2] Tentative Method of Test for Kinematic Viscosity (D 445 – 53 T), 1955 Book of ASTM Standards, Part 5, p. 192.

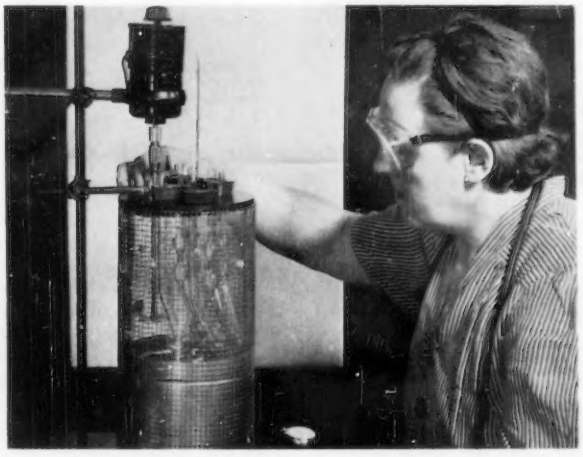

**Fig. 9.—Apparatus Used in the Determination of Low-Temperature Viscosities.**

with dry ice, well agitated by a mechanical stirrer, and the temperature is controlled manually by the addition of small pieces of dry ice to the bath.

Temperature measurement at 0 F and below is made with a high-precision mercury-thallium alloy thermometer. Experience has shown that an average operator can control temperature manually in this bath to well within 0.1 F total variation for any temperature over the −65 to +32 F range.

### Limitations of Viscosity-Temperature Characterizations

The inability of ASTM slope to express adequately viscosities at temperature extremes applies to all of the viscosity-temperature relationships proposed, on the basis of a limited range of measured viscosities. However, ASTM slope lends itself well to an expression involving the temperature extremes. In the tables of data illustrating deviations from the viscosity-temperature relationship of the ASTM chart, corresponding ASTM slope values are shown for the widest temperature interval for which experimental data are given. All extrapolated and interpolated viscosities are obtained by the use of the tables for ASTM slope prepared by Eby (**11**).

Table I shows the high-temperature viscosity behavior of six classes of synthetic fluids and mineral oils. They indicate that all of the fluid types tested show a measurable deviation from a straight line on the ASTM viscosity-temperature chart in the region of 500 to 700 F. Two of the fluids tend to give higher than predicted viscosities, while the remainder fall below the predicted values. Viscosity measurements at 707 F indicate that very few materials have been found which are sufficiently nonvolatile and possess sufficient thermal stability to produce a stable viscosity at this temperature.

### Low-Temperature Viscosity

The low-temperature viscosities of five classes of synthetics are presented in Table II. These materials are unusual in that all yield measured viscosities that are lower than the predicted viscosities at low temperature (−40 F). These synthetic materials all have a general resemblance in molecular structure. Their molecular structure shows a dense or congested center to which are attached groups that are linear in type. In many cases deviations from the ASTM viscosity-temperature curve are substantial for this type of molecule.

The low-temperature viscosity behavior of mineral-oil blends containing conventional polymeric viscosity-index improvers is shown in Table III. These data show viscosity values at low temperatures that are much higher than predicted. The first three compositions on this table have been studied previously for non-Newtonian behavior (**13, 14**). The latter two compositions are commercial hydraulic fluids which have been widely used for the past 10 to 14 yr. These two hydraulic fluids are designed for use to temperatures of −65 F. It is evident for fluids of this type that low-temperature behavior is not adequately predicted by viscosity-temperature expressions based only on viscosities measured at 100 and 210 F and the ASTM chart.

Low-temperature viscosity data for one synthetic fluid and four mineral oils are shown in Table IV. These data have been chosen to illustrate the effect of freezing point, cloud point, and pour point on low-temperature viscosities. Di-2-ethylhexyl sebacate shows good conformance to the ASTM viscosity-temperature chart at temperatures above its freezing point. Close to the freezing point (approximately

TABLE I.—COMPARISON OF MEASURED AND EXTRAPOLATED VISCOSITIES AT ELEVATED TEMPERATURES.

| Test Fluid | Measured Viscosity, centistokes | | | | ASTM Slope | | | Deviation of Measured Viscosity from ASTM Extrapolated[b] Viscosity, per cent | |
|---|---|---|---|---|---|---|---|---|---|
| | 100 F | 210 F | 490 F | 707 F | 210 to 100 F | 490 to 100 F | 707 to 100 F | 490 F | 707 F |
| Methylphenyl silicone | 44.4 | 15.5 | 3.25 | 1.46 to 1.37[a] | 0.347 | 0.389 | 0.448 | −17 | −36 |
| Chlorinated silicone | 59.9 | 21.2 | 4.52 | 2.2 to 2.0[a] | 0.315 | 0.344 | 0.373 | −14 | −25 |
| Tetra-2-ethylhexyl silicate | 6.79 | 2.23 | 0.59 | ... | 0.721 | 0.779 | ... | −10 | ... |
| Pentaerythritol ester | 22.4 | 4.54 | 0.83 | 0.42 to 0.59[a] | 0.717 | 0.775 | 0.857 | −15 | −27 |
| Naphthenic mineral oil (bright stock) | 201 | 12.0 | 1.16 | 0.57 to 0.66[a] | 0.815 | 0.832 | 0.846 | −4 | −8 |
| Naphthenic mineral oil (200 neutral) | 44.6 | 5.74 | 0.87 | 0.45 | 0.779 | 0.831 | 0.870 | −11 | −18 |
| Chlorinated aromatic hydrocarbon | 42.5 | 3.17 | 0.55 | ... | 1.15 | 1.07 | ... | +15 | ... |
| Tricresyl phosphate | 38.3 | 4.48 | 0.76 | ... | 0.895 | 0.881 | ... | +3 | ... |

[a] Viscosity variation observed over a 30-min period is attributed to thermal effects.
[b] Extrapolated viscosities were calculated for the indicated temperatures using the measured viscosities at 100 and 210 F.

TABLE II.—COMPARISON OF MEASURED AND EXTRAPOLATED VISCOSITIES AT LOW TEMPERATURES FOR SEVERAL SYNTHETIC MATERIALS.

| Test Fluid | Measured Viscosity, centistokes | | | ASTM Chart Slope | | Deviation of Measured Viscosity from ASTM Extrapolated[a] Viscosity at −40 F, per cent |
|---|---|---|---|---|---|---|
| | 210 F | 100 F | −40 F | 210 to 100 F | 210 to −40 F | |
| Dicapryl phthalate | 4.12 | 26.8 | 31 800 | 0.836 | 0.804 | −56 |
| Pentaerythritol ester | 4.54 | 22.4 | 5 310 | 0.713 | 0.702 | −21 |
| Tri-*n*-butyl phosphate | 1.06 | 2.66 | 46.9 | 0.903 | 0.849 | −42 |
| Tri-*n*-amyl phosphate | 1.36 | 3.79 | 114 | 0.863 | 0.824 | −37 |
| Di-*n*-butyl carbonate | 0.72 | 1.52 | 13.1 | 0.926 | 0.884 | −25 |
| Di-*n*-hexyl carbonate | 1.17 | 2.93 | 59.1 | 0.856 | 0.827 | −26 |
| Tri-2-ethylhexyl borate | 1.94 | 6.28 | 433 | 0.803 | 0.794 | −12 |

[a] Extrapolated viscosity was calculated at the indicated temperature using the measured viscosities at 100 and 210 F.

TABLE III.—COMPARISON OF MEASURED AND EXTRAPOLATED VISCOSITIES OF VISCOSITY-INDEX-IMPROVED FLUIDS AT LOW TEMPERATURES.

| Test Fluid[a] | Viscosity-Index Improver | | Measured Viscosity, centistokes | | | | ASTM Chart Slope | | | Deviation of Measured Viscosity from ASTM Extrapolated[c] Viscosity, per cent | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Name | Relative Molecular Weight[b] | 210 F | 100 F | 0 F | −40 F | 210 to 100 F | 210 to 0 F | 210 to −40 F | 0 F | −40 F |
| PRL 2913 | Polymethacrylate | 25 | 8.03 | 33.0 | 655 | 7 880 | 0.539 | 0.579 | 0.604 | +61 | +250 |
| PRL 2914 | Polymethacrylate | 160 | 8.65 | 33.2 | 538 | 5 020 | 0.505 | 0.546 | 0.568 | +61 | +230 |
| PRL 2924 | Polybutene | 315 | 7.34 | 33.3 | 817 | 10 700 | 0.586 | 0.618 | 0.636 | +49 | +170 |
| PRL 2828 | Specification 51-F-21 Navy hydraulic fluid | ... | 9.96 | 28.1 | 209 | 1 050 | 0.390 | 0.431 | 0.458 | +49 | +180 |
| PRL 2286 | Specification MIL-O-5606 aircraft hydraulic fluid | ... | 5.11 | 14.2 | 99.9 | 483 | 0.482 | 0.512 | 0.537 | +29 | +110 |

| Base Stock | Viscosity, centistokes | | | |
|---|---|---|---|---|
| | 210 F | 100 F | 0 F | −40 F |
| PRL 2857 | 2.24 | 8.75 | 176 | 2850 |
| PRL 3000 | 1.38 | 3.69 | 27.2 | 130 |

[a] Base-stock properties for these polymer blends are given in the following table. PRL 2857 is the base stock for PRL 2913, PRL 2914, and PRL 2924 test fluids. PRL 3000 is the base stock for PRL 2828 and PRL 2286 hydraulic fluids.

[b] Values given for the relative molecular weight are centistoke viscosities at 210 F for blends of 30 per cent by weight active polymer in a gas oil of about 3.7 centistokes viscosity at 100 F.

[c] Extrapolated viscosities were calculated for the indicated temperatures using the measured viscosities at 100 and 210 F.

TABLE IV.—COMPARISON OF MEASURED AND EXTRAPOLATED VISCOSITIES FOR FLUIDS AT TEMPERATURES NEAR THE CLOUD AND POUR POINTS.

| Test Fluid | ASTM Cloud Point, deg Fahr | ASTM Pour Point, deg Fahr | Measured Viscosity, centistokes | | | | | Deviation of Measured Viscosity from ASTM Extrapolated[b] Viscosity, per cent | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 210 F | 100 F | 10 F | 0 F | −65 F | 10 F | 0 F | −65 F |
| Di-2-ethylhexyl sebacate | <−65 | −65 | 3.34 | 12.7 | ... | 184 | 7 600 to 13 000 | ... | −1 | −5 to +63 |
| Naphthenic mineral oil (bright stock) | <−10 | −10 | 12.0 | 201 | 57 600 | 156 000 | ... | +1 | −2 | ... |
| Pennsylvania grade, 180 neutral + pour depressant | +25 | −10 | 6.01 | 40.4 | 1 990 | 9 550 | ... | +51 | +300 | ... |
| Dewaxed Pennsylvania grade, 200 neutral | +6 | 0 | 6.23 | 45.1 | 2 090 | 10 800 | ... | +17 | +210 | ... |
| Dewaxed Pennsylvania grade, 200 neutral + pour depressant | +6 | −20 | 6.32 | 46.3 | 1 630 | 4 010 | ... | −14 | +38 | ... |

[a] Melting point (approximate).

[b] Extrapolated viscosities were calculated for the indicated temperatures using the measured viscosities at 100 and 210 F.

−60 F), however, a wide variation in viscosity has been found, resulting in a substantial increase over the predicted viscosity.

The effect of cloud and pour points on the viscosity of mineral oils is illustrated by three Pennsylvania-grade neutrals (light oils). The effect of wax and pour depressants on low-temperature viscosity is a complex phenomenon which varies with cooling rates, agitation, shear rate, etc. A complete discussion of these variables is beyond the scope of this paper. All the viscosity determinations discussed here were conducted in low-shear modified Ostwald viscometers using a cooling rate of about 60 F per hr for cooling the oil from room temperature to the test temperature. The oil was not worked or agitated after cooling and prior to the viscosity determination. The measured viscosity is substantially greater than the predicted viscosity at 0 F. In all cases this happens below the cloud point of the oil.

Comparable data are shown in Table IV for a wax-free naphthenic viscous oil. In this case the measured 0 F viscosity agrees very well with the value predicted from the ASTM chart at 0 F. This is within 10 F of the ASTM pour point.

### ASTM Pour Point

This laboratory has studied the relationship between ASTM pour point and viscosity. Typical results are shown in Fig. 10. The viscosity equivalent to the ASTM pour point of mineral oils appears to be in the range of

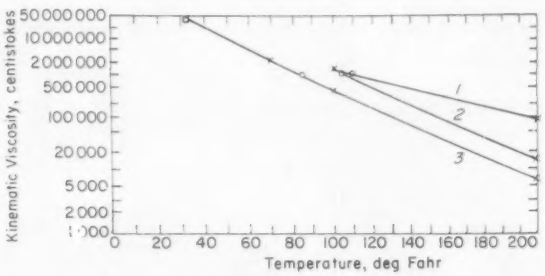


**Fig. 10.—Relationship between ASTM Pour Point and Measured Viscosities of Some Synthetic Fluids.**

○ = ASTM pour point, × = value determined in modified Ostwald viscometer, □ = value determined in PRL low-pressure viscometer, 1 = polyester, 2 = polymethacrylate AC 25, and 3 = AC 25 in ester.

TABLE V.—A COMPARISON OF MEASURED AND INTERPOLATED VISCOSITIES OF SEVERAL FLUIDS OVER A WIDE TEMPERATURE INTERVAL.

| Test Fluid | Measured Viscosity, centistokes | | | | | | | ASTM Slope for Maximum Temperature Interval | Deviation of Measured Viscosity from ASTM Interpolated[a] Viscosity, per cent | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 707 F | 490 F | 210 F | 100 F | 0 F | −40 F | −65 F | | 490 F | 210 F | 100 F | 0 F | −40 F |
| Di-2-ethylhexyl sebacate | ... | 0.77 | 3.34 | 12.7 | 193 | 1 420 | 8030 | 0.729 | ... | +11 | +11 | +15 | +10 |
| Pentaerythritol ester | 0.42 | 0.83 | 4 54 | 22.4 | 509 | 5 310 | ... | 0.810 | +20 | +54 | +68 | +40 | ... |
| Naphthenic mineral oil (bright stock) | 0.57 | 1.16 | 12.0 | 201 | 156 000 | ... | ... | 0.839 | +5 | +12 | +13 | ... | ... |
| Specification MIL-O-5606 hydraulic fluid | ... | ... | 5.11 | 14.2 | 99.9 | 483 | 2110 | 0.554 | ... | ... | −17 | −32 | −23 |
| PRL 2913 (polymethacrylate thickened fluid) | ... | ... | 8.03 | 33.0 | 655 | 7 880 | ... | 0.604 | ... | ... | −20 | −27 | ... |
| PRL 2924 (polybutene thickened fluid) | ... | ... | 7.34 | 33.3 | 817 | 10 700 | ... | 0.634 | ... | ... | −15 | −18 | ... |

[a] Viscosities for the intermediate temperatures have been interpolated from the measured viscosities at the temperature extremes.

TABLE VI.—A COMPARISON OF MEASURED AND EXTRAPOLATED VISCOSITIES FOR SEVERAL FLUIDS OVER A WIDE TEMPERATURE INTERVAL.

| Test Fluid | Measured Viscosity, centistokes | | | | | | | ASTM Slope for Interval 210 to 100 F | Deviation of Measured Viscosity from ASTM Extrapolated[a] Viscosity, per cent | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 350 F | 210 F | 100 F | 32 F | 0 F | −40 F | −65 F | | 350 F | 32 F | 0 F | −40 F | −65F |
| Di-2-ethylhexyl sebacate | 1.37 | 3.34 | 12.7 | ... | 193 | 1420 | 8030 | 0.701 | −3 | ... | +7 | +8 | +7 |
| Pentaerythritol ester | 1.57 | 4.54 | 22.4 | ... | 509 | ... | ... | 0.717 | −7 | ... | −15 | ... | ... |
| Naphthenic mineral oil (bright stock) | 2.61 | 12.0 | 201 | ... | 156 000 | ... | ... | 0.815 | +1 | ... | 0 | ... | ... |
| Specification MIL-O-5606 hydraulic fluid | 2.37 | 5.11 | 14.2 | 43.7 | ... | ... | ... | 0.482 | −1 | +10 | ... | ... | ... |
| PRL 2913 (polymethacrylate thickened fluid) | 3.06 | 8.03 | 33.0 | 182 | ... | ... | ... | 0.539 | +1 | +22 | ... | ... | ... |
| PRL 2924 (polybutene thickened fluid) | 2.74 | 7.34 | 33.3 | 208 | ... | ... | ... | 0.586 | +3 | +18 | ... | ... | ... |

[a] Extrapolated viscosities were calculated for the indicated temperatures using the measured viscosity at 100 and 210 F.

TABLE VII.—A COMPARISON OF MEASURED VISCOSITIES WITH INTERPOLATED VALUES BASED ON MEASURED VISCOSITIES OVER LIMITED HIGH AND LOW TEMPERATURE RANGES.

| Test Fluid | Measured Viscosity, centistokes | | | | | | ASTM Slope for Interval | | Deviation of Measured Viscosity from ASTM interpolated Viscosity, per cent | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 707 F | 490 F | 350 F | 100 F | 0 F | −40 F | 707 to 350 F | 100 to −40 F | 490 F[a] | 0 F[b] |
| Pentaerythritol ester | 0.42 | 0.83 | 1.57 | ... | ... | ... | 0.966 | ... | +8 | ... |
| Naphthenic mineral oil (bright stock) | 0.57 | 1.16 | 2.61 | ... | ... | ... | 0.879 | ... | 0 | ... |
| Specifications MIL-O-5606 hydraulic fluid | ... | ... | ... | 14.2 | 99.9 | 483 | ... | 0.571 | ... | −12 |
| PRL 2913 (polymethacrylate thickened fluid) | ... | ... | ... | 33.0 | 655 | 7 880 | ... | 0.644 | ... | −15 |
| PRL 2924 (polybutene thickened fluid) | ... | ... | ... | 33.3 | 817 | 10 700 | ... | 0.664 | ... | −10 |

[a] Interpolated viscosities were calculated using the measured viscosities at 707 and 350 F.
[b] Interpolated viscosities were calculated using the measured viscosities at 100 and −40 F.

50,000 to 400,000 centistokes, depending on the amount of wax encountered.

A large number of blends of synthetic materials have been studied at low temperatures and high viscosity levels in a capillary opaque-type viscometer, and in a few cases in a capillary viscometer under an applied pressure head. The rate of shear involved in the viscometer, using the applied head for the point shown in Fig. 10, is approximately 0.1 $sec^{-1}$. These synthetics show no evidence of insolubility or phase change at the pour point. In all cases opaque-type viscometers have been used to measure viscosity below the measured ASTM pour point. In a viscometer using an applied head a viscosity of 43 million centistokes was measured and reproduced at a shear rate of 0.1 $sec^{-1}$. In the case of these synthetic materials, the ASTM pour point occurs consistently at a viscosity level of 1 to 1.2 million centistokes. The shape of the ASTM viscosity-temperature curve shows no unusual behavior at or below the ASTM pour point. These data indicate that most mineral oils, including those which appear to be wax free, exhibit some sort of a phase change at the viscous pour point.

## Viscosities at Three or Four Temperatures

It has been shown that several compositions typical of modern trends in fluids and lubricants are not adequately characterized over their useful range of operation by the expressions commonly used to denote their viscosity-temperature characteristics. It is believed that the use of three or four measured viscosities (instead of two) and the ASTM slope for the maximum temperature interval can be combined to express adequately the viscosity-temperature characteristics of all of the

lubricant types studied thus far. The use of three or four measured viscosities allows accurate interpolation of intermediate viscosities over the entire temperature range.

The use of two measured viscosities and the ASTM slope for a wide temperature interval as a means for obtaining interpolated intermediate viscosities is shown in Table V. Two synthetics, three polymer thickened mineral oils, and a viscous naphthenic mineral oil are included in this study. These data indicate that predicted viscosities for the temperature range of 210 to 0 F show considerable deviation from the measured viscosities.

Data for the same fluids are also shown in Table VI. Here an attempt has been made to show the temperature range for these fluids for which 100 and 210 F viscosity data adequately define their viscosity-temperature characteristics. Measured viscosities at 350 and 32 F have been added for this comparison. The data indicate relatively good conformance to the ASTM chart for all of the fluids tested over the range of 350 to 100 F. The pentaerythritol ester and the polymer thickened blends show deviation from the ASTM chart at temperatures of 0 and 32 F, respectively. The viscosities of the mineral oil and di-2-ethylhexyl sebacate show good conformance to the ASTM chart over the entire range shown in Table VI.

Table VII illustrates the use of measured viscosities to define adequately the viscosity-temperature curve at the temperature extremes. Two temperature intervals are shown using different fluid types. These intervals are 350 to 700 F, and 100 to −40 F. The preceding table showed that measured viscosities at 350 and 100 F are sufficient to define all intermediate values. These data indicate that intermediate viscosities in any portion of the temperature scale can be adequately estimated by interpolation.

## Conclusion

The ASTM slope shows no irregularities over a wide range of viscosity-temperature characteristics, and this is not the case with viscosity index at values of about 150 and higher. ASTM slope values can be easily measured with good precision over any desired temperature interval. The use of measured viscosities at the temperature extremes encountered in a specific application is recommended. It is not difficult to make these measurements at temperatures ranging from +700 to −65 F, provided that the fluid remains homogeneous. Three or more measured viscosities, spaced over the temperature interval of interest, and the ASTM slope for this interval, is a very good way to characterize the fluid's viscosity at all other temperatures.

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## *Homes for the Indians*

IT HAS been recognized universally that capital expended on research pays high dividends in the long run. India has subscribed to this belief by the establishment of thirteen national research institutes, which, in cooperation with the Five-Year Plans may change the pattern of industry and agriculture of India within a relatively short time.

The national laboratories, as pointed out by the Prime Minister on the occasion of the opening of the Central Building Research Inst., Roorkee, are basic institutions from which "waves of knowledge will emanate to improve India and better the living conditions of our people." He observed: "It is not easy to give a new face to so large a country which contains one-fifth of the world's population. Perhaps the only way of doing this difficult job is by creating among the people a temper of science so that it takes away the rut of sluggish habit and ushers in an era of blissful prosperity."

The Central Building Research Inst. at Roorkee is one in the chain of the national institutes entrusted with the development of Indian building research in general.

Building research as applied to the building of houses concerns itself with three main problems: to establish standards of performance for houses and to show how they can be met; to improve materials and methods of construction; and to reduce costs of building. Thus, research must deal with problems of quality and cost. In addition, it must not be satisfied with results obtained in the laboratory, but must secure the application of these results to actual construction.

Surveys should be carried out to determine the performance of existing material with a view to suggesting improvements. This is being attempted by the Central Building Research Inst. and the work of coordinating all building research in the country is being supervised by the Building Research Committee of the Council of Scientific and Industrial Research which consists of representatives from all over the country—from Government, professional, and educational institutions as well as from building industry and the private enterprise.

# PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column

The following ASTM members were among 39 ACS members who recently received 50-year membership certificates from the American Chemical Society: **W. D. Collins,** retired chemist, U. S. Geological Survey; **W. F. Faragher,** formerly with Mellon Institute, University of Pittsburgh, Universal Oil Products Co., Socony-Mobil Oil Co., and Houdry Corp.; **Dudley K. French,** Consultant, formerly with Dearborn Chemical Co.; **Frant Garatt,** formerly vice-president and technical, now senior, consultant, Universal-Cyclops Steel Co.; **George Herbert Tomlinson,** vice-president, Howard Smith Paper Mills (Montreal); **John W. Weiss,** Consulting Chemical Engineer, John M. Weiss & Co.; and **Bruce Williams,** Bruce Williams Laboratories.

**Donald H. Anderson** has been named Assistant Superintendent of the Industrial Laboratory of Kodak Park works, Eastman Kodak Co.

Past-President **L. C. Beard Jr.,** for many years Assistant Director, Socony Mobil Laboratories, Socony Mobil Oil Co., has been named Coordinator of Research. Dr. Beard has been a most active worker in ASTM, and this is his ninth year of service as a member of the Board of Directors; in his capacity as the Senior Past-President he now heads the Society's important Finance Committee. While his chief technical interests have been in Committee D-2 on Petroleum Products and Lubricants, where he has served on many subcommittees and the advisory subgroup, he also has assisted on a number of administrative committees.

**Harry C. Bell** has been elected Vice-President of Engineering, Research and Development, Ohio Injector Co., Wadsworth, Ohio.

**Don H. Blackmar,** formerly with Modine Manufacturing Co., Racine, Wis., is now Chief Metallurgist, LeRoi Div., Westinghouse Air Brake Co., Milwaukee, Wis.

**James H. Bly** has joined the Sales Division, High Voltage Engineering Corp., Cambridge, Mass. He was formerly with X-Ray, Inc., Detroit, Mich., and Pratt & Whitney Aircraft, East Hartford, Conn.

**Frank R. Bridges,** until recently with The Gamewell Co., Newton Upper Falls, Mass., is now General Manager, SAFA Alarm Div., Fyr-Fyter Co., Orrville, Ohio.

**Arthur F. C. Brown** has relinquished his post with the United Kingdom Scientific Mission, Washington, D. C. He is now Principal Scientific Officer, The National Physical Laboratory, Teddington, Middlesex, England.

**Milton D. Burdick** has been named to head the newly organized Engineering Ceramics Section of the Mineral Products Division of the National Bureau of Standards. Mr. Burdick has represented the Bureau on ASTM Committee C-21 on Ceramic Whiteware for many years.

**Gerald Burr,** formerly with Curtiss-Wright, New York City, is now Research Engineer, Republic Aviation Corp., Farmingdale, L. I., N. Y.

**Robert M. Campbell,** Chairman of the Department of Ceramic Engineering at the State University of New York, College of Ceramics at Alfred University, was inaugurated as President of the National Institute of Ceramic Engineers at the group's annual meeting held in New York in April in conjunction with the 58th annual meeting of the American Ceramic Society.

**John J. Chyle,** Director of Welding Research, A. O. Smith Corp., Milwaukee, Wis., has been elected President of the American Welding Society. Announcement was made at the Annual Meeting of the Society in May in Buffalo.

**Francisco J. Cordova,** formerly General Manager, Testing Services Corp., South Bend, Ind., is now President and Chief Engineer, Westville Engineering Co., Westville, Ind.

**H. E. Corwin,** from Syracuse University Research Inst., is now Director of Chemical Development for the General Package Div. of Diamond Match Co., Palmer, Mass.

**James J. Curran,** for 20 years Chief Metallurgist, Walworth Co., Greensburg, Pa., and previously for 13 years with Henry Souther Engineering Co., is now on the faculty of the University of Pittsburgh as Assistant Professor of Metallurgical Engineering. Through the years Mr. Curran has served on many ASTM ferrous and non-ferrous groups.

**John Delmonte,** President, Furane Plastics, Inc., Los Angeles, Calif., recently received the first Western Plastics Award. He was honored as having done most during 1955 to promote growth and increase the stature of the plastics industry in 11 western states and Texas. Active in ASTM for many years, Mr. Delmonte has served on Committees D-14 on Adhesives and D-20 on Plastics, also has participated in Southern California District work, serving several terms as Councilor and a term as Assistant Secretary of the District. He is in charge of the Plastics Sessions scheduled for the Society's Second Pacific Area National Meeting in Los Angeles in September.

**Harry W. Dietert,** Chairman of the Board, Harry W. Dietert Co., Detroit, Mich., was elected Vice-President of the American Foundryman's Society in May at the Society's Annual Business Meeting in Atlantic City.

**L. M. Diran** has been appointed in charge of cast constructional steel developments, Development and Research Division, International Nickel Co., New York City. Mr. Diran joined the ferrous casting section of the company's research laboratory in Bayonne, N. J., in 1954.

**Erb N. Ditton** is now associated with The Linen Thread Co., Research Department, Paterson, N. J.

**William A. Dupraw,** Analytical Research Chemist, Armour Research Foundation, received the ARF Chemistry and Chemical Engineering Department's Award of Scientific Merit, presented for outstanding individual scientific accomplishment. He developed a method of analysis of tin in titanium alloys as part of cooperative work with the Metals Advisory Committee for Titanium, of which he is a panel member.

**Herman C. Fischer,** formerly with Wasco Chemical Co., Sanford, Me., is now Research Chemist, New Jersey Zinc Co. (of Pa.), Palmerton, Pa.

**Charles R. Funk,** until recently Chief Metallurgist, has been appointed Manager of Metallurgy and Engineering, ALCO Products, Inc., Latrobe, Pa.

**Neil B. Garlock** resigned from Eagle-Picher Co., Joplin, Mo., to join the Scientific Section of the National Paint, Varnish & Lacquer Assn., Washington, D. C.

**Herbert J. Gilkey,** Head, Department of Theoretical and Applied Mechanics, Iowa State College, Ames, recently received a Life Membership Certificate at a meeting of the Iowa Section of the American Society of Civil Engineers. As noted elsewhere in this BULLETIN, Professor Gilkey was elected to ASTM Honorary Membership at the recent annual meeting; also was elected to honorary membership in ASTM Committee C-9 on Concrete and Concrete Aggregates.

**John W. Harsch,** Director of Engineering, Leeds & Northrup Co., Philadelphia, Pa., was one of four recipients of the 1956 Trinks Industrial Heating Awards, recognizing important contributions to the science of industrial heating. Mr. Harsch holds 13 patents including that for the Homo Method of forced-convection heating and for his work in gas potentials.

**Robert L. Heath,** formerly Metallurgical Engineer, Climax Molybdenum Co.

(*Continued on page 102*)

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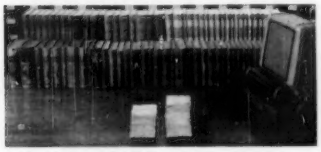
# Kodak reports to laboratories on:

**how goodly the body of microprint literature is . . . not jarring the radiographer's delicately tuned sensibilities . . . three reagents**

## A snowball rolling

Somewhere your librarian has to draw the line. Some books and bound volumes simply cost too much in money and space for the good a given organization is likely to get from them. These words are promotion for the microprint idea. It pushes the line which your librarian has to draw about as far as anyone could want it pushed.



A microprint card* is a piece of stiff paper, generally 3″ x 5″ or larger, on which can appear as many as 60 greatly reduced book pages. These cards are read with the aid of optical devices. Of these we are prejudiced in favor of the *Kodagraph Microprint Reader* as the most comfortable to use.

A goodly body of the technical literature in the sciences, the humanities, and even the law and finance is now on sale in this form. To illustrate just how goodly is the body, we have just published a booklet entitled "What's Available on Microprint Cards." It is an attempt at a condensed consolidated catalog of the output of all microprint card publishers known to us and willing that we publicize their offerings. We alone are footing the bill for this project.

Our motives, of course, are selfish. Our scheme with the booklet is to convince a lot more scholars, librarians, and librarians' bosses that there is enough microprint literature around to justify the acquisition of microprint readers. Then, just as surely as the telephone, radio, and television industries grew, microprint grows. The publisher's market grows. The number of titles grows. The need for microprint readers where researchers foregather becomes more obvious. It even occurs to more large companies that since their research people already have readers for the open microprint literature, the companies' own internal reports might be more efficiently circulated in microprint form.

*Since, as all this comes to pass, we shall sell more and more photographic materials with which to make microprint cards, there is no reason to hesitate about writing for a free copy of "What's Available on Microprint Cards" to Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y.*

*The term "Microcard" is applied only to certain makes of microprint cards.

## A new x-ray film

Monotonous is the word. Looking at radiographs of castings and weldments, which are what go on most *Kodak Industrial X-ray Film*, can be monotonous unto distraction. Fortunately for public safety, radiographers are able to stand it and even to keep themselves alert for certain occasional small signs that signal danger. Rarely would the signs attract the attention of the uninitiated. Only after long familiarity with the radiographic appearance of sound metal does the sight of the unsound set off the alarm. It is easy to see why changes that would alter the appearance of radiographs are resisted.

Nevertheless, progress ought not be barred, so long as it does not jar the radiographer's delicately tuned sensibilities. Right now progress takes the form of displacing his favorite *Kodak Industrial X-ray Film, Type A*, with *Type AA*. His radiographs look the same, but the speed is up 30% for low-voltage x-rays, 70% for medium-voltage, 130% for high-voltage x-rays and gamma-rays such as the boys are now getting from $Co^{60}$ and $Cs^{137}$. If he wants the same film density as before, he can now get it with less milliamperage or shorter exposure time. If he cares to adjust himself to looking at higher densities, he can give the same exposure as he used to and see more detail, since the contrast continues to increase as density increases. As a third alternative, he can consider that insofar as the greater mass of metal he can get through is concerned, we have in effect bumped up the capacity of his equipment for him.

*There are many interesting facts about film and x-rays that Eastman Kodak Company, X-ray Division, Rochester 4, N. Y., can tell you, if you can only ask the right questions.*

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*2-(2,4-Dinitrophenylazo)-1-naphthol-3,6-disulfonic Acid Disodium Salt* (Eastman 7121) turns from blue to yellow to mark the souring of milk. Also useful in judging meat. In short, an indicator with a sharp and conspicuous color change over the pH range 6.0 to 7.0. Aurin is easier to remember and covers the same pH range but with too subtle a color change from amber to pink. Can be affectionately referred to as "Nitrazine Yellow" in requesting abstract.

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BULLETIN 56

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New from Emil Greiner! The High Temperature Saybolt Viscosimeter... ideal for determining the viscosity of asphalts, road oil and fuel oils at test temperatures from 100°F. to 475°F.

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| G19801 | Displacement Ring, stainless steel, for use in overflow gallery of viscosity tube when running viscosity tests on asphalt..... each | 12.50 |
| G9090 | Viscosity flask, pyrex brand glass, capacity 60 ml each | 1.59 |
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(*Continued from page 95*)

of Michigan, Chicago, Ill., is now Director of Quality Control, Rocketdyne Division of North American Aviation, Inc., Canoga Park, Calif.

**G. O. Hoglund,** Head of Welding Section, Alcoa Process Development Laboratory, New Kensington, Pa., was elected 2nd Vice-President of the American Welding Society.

**Walter H. Holcroft,** Vice-President, Holcroft & Co., Detroit, Mich., was "saluted" in a recent issue of *Iron Age* for his reputation for treating people kindly as well as for his knowledge of heat treating. Credited with the invention of many new processes, Mr. Holcroft, "one of the nation's leading experts on heat treating, has an exceptionally cool temperament."

**Emil G. Holmberg** has joined the Corrosion Engineering Section of the International Nickel Co.'s Development and Research Division, New York City. For the past nine years he was Chief Metallurgist of the Alloy Steel Products Co., Linden, N. J.

**William J. Howell, Jr.,** formerly Consultant in Fiberglas Plastics, New York City, is now Manager, Sales Development, Tru-Scale, Inc., Wichita, Kans.

**W. C. Huntington** has retired as Head of the Department of Civil Engineering, University of Illinois, Urbana. Professor Huntington has been affiliated with ASTM since 1927.

**Charles H. Joseph, Jr.,** formerly Director of Quality Control at American Greetings Corp., is now Director of Operations Analysis for the Cleveland, Ohio, greeting firm.

**Lewis V. Judson,** Chief of the Length Section, Optics and Metrology Div., National Bureau of Standards, has been given the Department of Commerce Silver Medal for Meritorious Service, recognizing his "extremely competent performance for 38 years in the field of length standards and precise length determinations." Dr. Judson is Chairman of Subcommittee 10 on Sieves of ASTM Committee E-1 on Methods of Testing.

**Henry A. Kafarski,** formerly Research Engineer, Ford Motor Co., Dearborn, Mich., is now President and Factory Manager, Chemical Processing, Inc., Detroit, Mich.

**W. Newlin Keen** has been appointed Assistant Manager of the Akron District Sales Office of the Elastomers Division of E. I. du Pont de Nemours & Co., Inc. He has been associated with the du Pont Co. for the past 15 years in various capacities. In ASTM Mr. Keen participates actively in the work of Committee D-11 on Rubber and many of its subgroups; he is Chairman of Subcommittee XIX on Tests for Properties of Rubber and Rubber-Like Materials in Liquids.

**K. Koyanagi,** formerly Managing Director, Japan Cement Engineering Assn., is now Director, Tohoku Kogyo Co., Ltd., Tokyo, Japan.

**George W. Land,** until recently Combustion Engineer, Peabody Coal Co., is now Industrial Consultant, Truax-Traer Coal Co., Chicago, Ill.

**Emil A. Lucas,** Executive Vice-President of the Molybdenum Corp. of America, Washington, Pa., in addition to being recently awarded an honorary Doctor of Science degree by Thiel College, was elected to its Board of Trustees. Active in ASTM for many years, Dr. Lucas currently is vice-chairman of Committee A-9 on Ferro-Alloys, and chairman of its Subcommittee on Specifications. He also is active in Committee E-3 on Chemical Analysis of Metals.

Following a career of shipyard employ that began in 1917 as a physical metallurgist, **Carlton G. Lutts,** Head of the Boston Naval Shipyard Materials Laboratory, retired April 30. Recognized throughout the Navy as an authority on the manufacture of chain and rope, Mr. Lutts was the first president of the Society for Nondestructive Testing when it was founded in the Boston Shipyard in 1942. In 1953 he was presented with a Meritorious Civilian Service Award, pointing out his accomplishments from the time he was coinventor with the late master mechanic Albert M. Leahy of the Forge and Chain Shop of the famous Die-Lock Chain; and further citing his notable achievements in the application of a million-volt X-ray machine to take pictures of the internal parts of metal castings and the initiation of the use of a small portable X-ray machine to inspect welding on ships. A longtime ASTM member, Mr. Lutts has been especially active in the work of the New England District Council, being a charter member of this group, and serving four years as Secretary, two years as Vice-Chairman, and just completing a two-year term as Chairman. He resides at Cabot Farm, Orne St., Salem, Mass.

**Vincent T. Malcolm,** for many years Director of Research, The Chapman Valve Manufacturing Co., Indian Orchard, Mass., has been granted retirement from all operational duties within the plant. However, at the request of C. Goodwin Carter, President of the Company, he will retain the title of Director of Research, and will act as Consulting and Advisory Engineer on engineering problems. Affiliated with ASTM for many years, Mr. Malcolm has served ably and constructively on numerous technical committees of the Society. In recognition of valued contributions he was honored with an ASTM Award of Merit at the recent annual meeting (as noted elsewhere in this BULLETIN).

**John Marsh** has been named by Bethlehem Steel Co., Bethlehem, Pa., to succeed R. S. Dougherty, retired, as Manager of Research.

**S. C. Massari,** until recently Manager, Foundry Division, Hansell-Elcock Co., Chicago, Ill., has been appointed Director of Research, National Engineering Co., in the same city. Mr. Massari, who was Technical Director, American Foundrymen's Society from 1945 to 1953, presented the Charles Edgar Hoyt Memorial Lecture at the AFS Atlantic City convention in May, speaking on "Marketing Your Product."

**John S. McBride** has been named Technical Manager, Plastics Reinforcement Laboratory, Owens-Corning Fiberglas Corp., New York City. For the past five years a section manager, in his new capacity Mr. McBride will direct research and testing programs to establish data necessary to increase the use of reinforced plastics both in engineered structural applications and in other products for which there are existing markets.

**John W. McBurney,** a nationally known authority in the field of building technology, retired from the staff of the National Bureau of Standards on May 31 after 30 years of service. A longtime ASTM member, Dr. McBurney has been very active in the technical work of the Society in the field of building materials, being a past officer of both Committees C-12 on Mortars for Unit Masonry, and C-15 on Manufactured Masonry Units. In recognition of valued contributions he was honored with an ASTM Award of Merit at the recent annual meeting (as noted elsewhere in this BULLETIN).

**John F. McMahon,** Dean of State University of New York College of Ceramics at Alfred University, was installed as President-elect of the American Ceramic Society at the society's 58th annual meeting in New York in April.

**Kenneth J. Miller,** formerly Superintendent of Research, Houghton Vix-Syn Co., Hopkins, Minn., is now Director of Research, Vulcanized Rubber and Plastics Co., Morrisville, Pa.

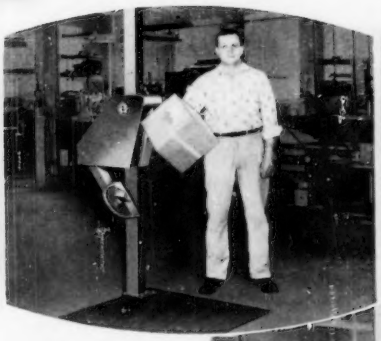
**R. A. Millermaster** has been elected Vice-President of Development, Cutler-Hammer, Inc., Milwaukee, Wis. He had been Manager of Development.

**James Mitchell,** Director of Quality Control, Avondale Mills, Sylacauga, Ala., has been promoted to Assistant Secretary of the corporation.

**Forest C. Monkman, Jr.,** recently was appointed Director of Research, Walworth Co., Boston, Mass.

ASTM Director **John C. Moore,** formerly Technical Director of the National Paint, Varnish & Lacquer Assn., Washington, D. C., has assumed responsibilities as Technical Director of the laboratory of Coatings Research Group, Inc., Bethesda, Md., recently established by 19 regional paint manufacturers to carry on a joint program of research and development in protective coatings. These include a number of ASTM members. Officers of

(*Continued on page 104*)



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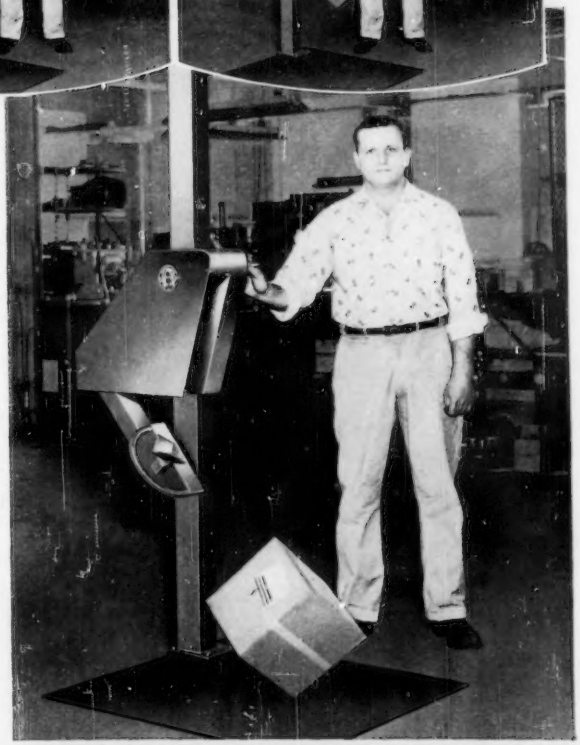

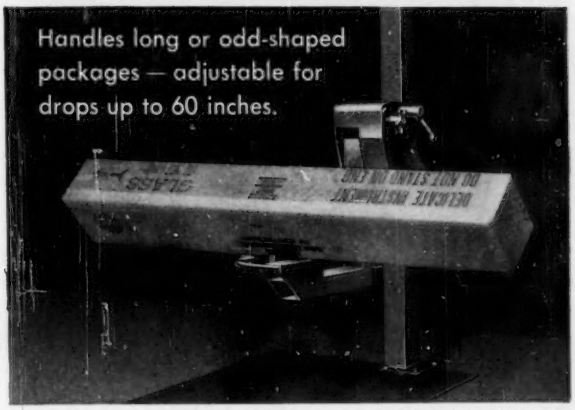


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(Continued from page 102)

the Group are: President—Horace S. Felton, President of Felton, Sibley & Co., Philadelphia; Vice-President—Byron F. Swackhamer, President of Yarnall Paint Co., Philadelphia; Treasurer—**Hiram P. Ball,** Secretary-Treasurer of **Ball Chemical Co.,** Pittsburgh; and Secretary—Howard Berman, Sales Manager, Breinig Brothers, Inc., Hoboken, N. J.

**Coleman P. Morgan,** formerly Consultant, Coleman P. Morgan Associates, Yardley, Pa., is now President, Pelmor Laboratories, Inc., Newtown, Pa.

**W. A. Mudge** has been appointed Special Representative on Educational Programs of the International Nickel Co. of Canada, Ltd., and its U. S. subsidiary, The International Nickel Co., Inc. According to Henry S. Wingate, President of the two companies, "this newly created post in the Office of the President is an extension of International Nickel's long established educational program and reflects continued realization of the importance of technology in modern society." Dr. Mudge will relinquish his duties as Director of the Technical Service Section of the Development and Research Division, which position he has held since 1947. Active in ASTM for many years, Dr. Mudge currently serves as Secretary of Committee B-2 on Non-Ferrous Metals and Alloys.

**Ralph H. Munch** has been promoted to an Assistant Director of Research at Monsanto Chemical Co., Organic Chemicals Div.

**Howard K. Nason** became General Manager of the Research and Engineering Div., Monsanto Chemical Co., St. Louis, Mo., in April. Subsequently he was elected a Vice-President by the Board of Directors of the company. He has been associated with Monsanto in various capacities since 1936. Very active in ASTM technical and administrative work for many years, Mr. Nason has served on Committees D-1 on Paint, D-14 on Adhesives, and D-20 on Plastics. He served two terms on the Board of Directors of the Society; was a member of the Administrative Committee on Papers and Publications for six years; and currently serves on the ASTM Ordnance Advisory Committee.

**George A. Perley,** widely known chemical engineer, retired June 1 as Associate Director of Research, Leeds & Northrup Co., Philadelphia, Pa. He had been associated with Leeds & Northrup since 1929. A major, Ordnance Corps, during World War I, and recipient of a Certificate of Appreciation from the Office of Scientific Research and Development for work in World War II, he holds ten patents. He has contributed the results of research and study in various aspects of storage cell design, photochemistry, beryllium extraction, ammonia oxidation, sulfuric acid production, and chemical education. In ASTM Mr. Perley has served through the years on Committees D-9 on Electrical Insulating Materials, D-19 on Industrial Water, D-22 on Methods of Atmospheric Sampling and Analysis, and Subcommittee 22 on Hydrogen Ion Determinations of Committee E-1 on Methods of Testing.

**Garnet P. Phillips,** General Supervisor, Foundry Research, International Harvester Co., Chicago, Ill., has been elected a Director of the American Foundrymen's Society for a three-year period.

**H. R. Redington** recently retired as Specifications Engineer, National Tube Division, United States Steel Corp., Pittsburgh, Pa. Mr. Redington has been very active in the technical work of ASTM for many years, especially in Committee A-1 on Steel and its Subcommittees IX on Steel Tubing and Pipe, and XXII on Valves, Fittings, Pipings and Flanges for High-Temperature and Subatmospheric Temperatures; also the Special Subcommittee on Stainless Tubing Specifications. He has been a member of the Pittsburgh District Council since 1949.

**Irving Roberts** has been appointed Director of Planning, Reynolds Metals Co., Richmond, Va.

(Continued on page 106)

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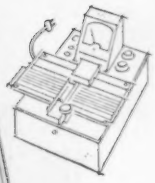

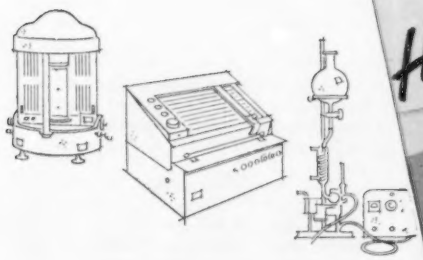

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(*Continued from page 104*)

**J. Romney,** formerly associated with the Technological Dept., W. B. Dick and Co., Ltd., London, England, is now Assistant Group Technical Manager, C. C. Wakefield and Co., in the same city.

**Arnold S. Rose,** until recently with I-T-E Circuit Breaker Co., Philadelphia, Pa., is now with Radio Corporation of America, Harrison, N. J.

**Raymond J. Rosenberger** of Bay Village, Ohio, has been named Chief, Specification Division, Central District, The H. K. Ferguson Co., Cleveland, Ohio. Until January 1956 Mr. Rosenberger was Cleveland Office Manager for Gilbert Associates, Inc., engineers and consultants of Reading, Pa.

**Bruno Sachs,** formerly with Quiet-Heet Manufacturing Corp., Newark, N. J., is now Vice-President, Tenney Engineering, Inc., Union, N. J.

ASTM President **Rudolph A. Schatzel,** vice-president and director of engineering for the Rome Cable Corp., Rome, N. Y., was awarded an honorary Doctor of Science degree at Union College commencement exercises in June. This year's graduation ceremony, Union's 161st, marked Dr. Schatzel's third appearance on the College's commencement platform in the role of degree recipient. He graduated from Union with a B.S. in Chemistry in 1921, and was awarded his M.S. two years later. Dr. Schatzel's citation referred to his national distinction in ASTM, as a research chemist in the area of rubber and plastic insulation for cables, and key posts he held in the War Production Board, the Office of Scientific Research and Development, and the U. S. Technical Intelligence Committee; also mentioned his achievements as President of the Board of Education, City of Rome, and President of the Board of Trustees of the Central New York School for the Deaf.

**Herbert F. Schiefer,** Textile Physicist in the Organic and Fibrous Materials Div., National Bureau of Standards, Washington, D. C., has been awarded the Department of Commerce Gold Medal for Exceptional Service, recognizing his "outstanding contributions to textile science and technology." Internationally known in the textile field, he has been with the Bureau since 1929. He has developed and invented many devices for testing the properties of fibers, yarns, and fabrics—a number widely used by the textile industry today. Very active in ASTM Committee D-13 on Textile Materials, Dr. Schiefer received the 1950 Harold DeWitt Smith Memorial Medal, established by Committee D-13.

**Earle E. Schumacher,** Metallurgical Director, Bell Telephone Laboratories, Murray Hill, N. J., recently was awarded the honorary Doctor of Engineering degree by the South Dakota School of Mines and Technology. The degree was conferred in May at annual commencement ceremonies at the school in Rapid City, S. Dak. Dr. Schumacher also delivered the commencement address to the graduates, the title of his talk being "The Contract of an Engineer." In ASTM, Dr. Schumacher has been very active for many years in Committee B-2 on Non-Ferrous Metals and Alloys, currently serving as a Vice-Chairman of this main group, and as Chairman of its Subcommittee on Miscellaneous Refined Metals and Alloys.

**F. S. Schwinn,** District Engineer, Missouri Pacific Lines, Houston, Tex., recently retired from active railroad service. He had been representative of the Lines in ASTM for many years. Mr. Schwinn lives at 4118 Tartan Lane, Houston 25, Tex.

**Walter Shewhart** recently retired after 38 years of service with the Bell Telephone Laboratories, Murray Hill, N. J. Often spoken of as the "Father of Quality Control" Dr. Shewhart had made many contributions in the research work of the Laboratories. **Harold F. Dodge,** Quality Results Engineer, Bell Telephone Laboratories, New York City, and Chairman of ASTM Committee E-11 on Quality Control of Materials, gave a capsule recital of the contributions of Dr. Shewhart's long and brilliant career at a retirement luncheon tendered him by some 86 members of Bell Telephone Laboratories and

(*Continued on page 108*)


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**MOST USEFUL**
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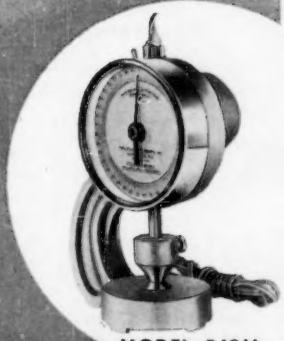

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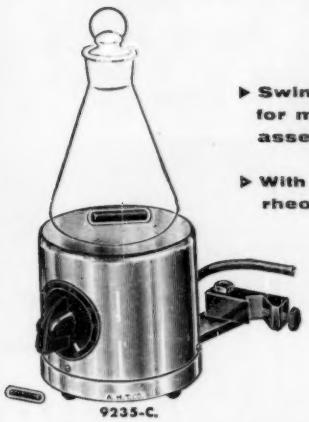

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(*Continued from page 106*)

friends at the Bottle Hill Tavern, in Madison, N. J.

**Harris Pearson Smith,** Professor, Agricultural Engineering, Texas Agricultural and Mechanical College, Agricultural Engineering Dept., College Station, Tex., was one of two recipients of Cyrus Hall McCormick Gold Medals, presented by the American Society of Agricultural Engineers, and honoring outstanding engineering achievement in the field of agriculture. Mr. Smith's connection with Texas A&M College began in 1919.

**Harry N. Stevens,** with The B. F. Goodrich Co. since 1935, has been named Director-Research Operating, Akron, Ohio. He had been Research Coordinator in the company's Research Center, Brecksville, Ohio.

**R. W. Swinehart** has been promoted to Superintendent of Cellulose Products, Dow Chemical Co., Midland, Mich.

**Ferruh Taskin** is now Research Associate, Concrete Laboratory, School of Civil Engineering, Purdue University, Lafayette, Ind.

**Malcolm L. Taylor,** Manager of Technical Div., Savannah plant of Union Bag & Paper Corp., has been promoted to Technical Director of the company.

**Stephen Teleshak** until recently with Firth Sterling, Inc., Pittsburgh, Pa., is now Manager, Metallurgical Department, Pittsburgh Testing Laboratory, in the same city.

**Thomas D. Tifft** recently retired as Chief Engineer, Sinclair Refining Co., New York City. He had represented his company for many years on Committee A-1 on Steel and its Subcommittees IX on Steel Tubing and Pipe, and XXII on Valves, Fittings, Pipings and Flanges for High-Temperature and Subatmospheric Temperatures.

**A. G. Timms,** formerly Senior Materials Engineer, Division of Physical Research, Bureau of Public Roads, Washington, D. C., is now Consulting Engineer, 5208 Western Ave., Chevy Chase, Md.

**James S. Vanick,** Metallurgist, International Nickel Co., New York City, received the 1956 William H. McFadden Gold Medal of the American Foundrymen's Society "for outstanding contributions to the Society and for valuable service to the ferrous castings industry over many years." The award recognizes among other attributes his metallurgical competence, broad experience in foundry problems and practice, and his never-failing desire to help the other fellow. Mr. Vanick's contact with the ferrous foundry industry spans 40 years and two World Wars. Affiliated with many organizations, he has been active in ASTM technical work for many years. He has participated most intensively in the activities of Committee A-3 on Cast Iron, heading this main committee for five years, also serving as chairman of several of the subcommittees. He has been active in New York District work for many years.

Industrial Research Institute has named **Thomas H. Vaughn,** Vice-President of Colgate-Palmolive Co., as President-elect and Director of the Industrial Research Institute.

**Arthur S. Watts,** Professor Emeritus, Ohio State University, Columbus, Ohio, was presented the 1956 Albert Victor Bleininger Award by the Pittsburgh Section of the American Ceramic Society. This award is given annually by the Section for meritorious achievement in ceramics. Professor Watts, who is holder of numerous patents and author of many technical articles, was honored for his long years of service as a ceramic educator and his many contributions in the field of ceramics. ASTM Committee C-21 on Ceramic Whitewares has been privileged for many years to have the services of Professor Watts on its main group, Executive Committee, and Subcommittees I on Nomenclature, and II on Tests and Specifications. He has given unstintingly of his time and knowledge, especially as chairman of the group concerned with nomenclature.

(*Continued on page 110*)

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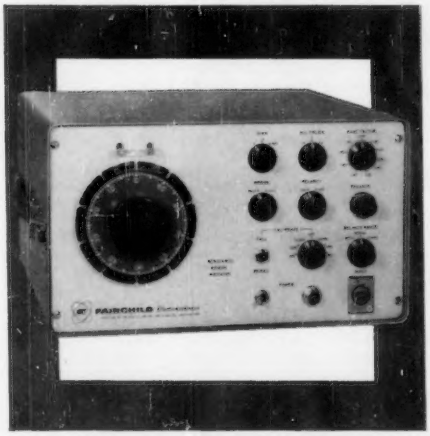

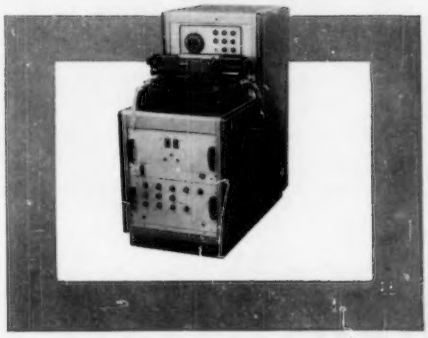

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- Output: Self-balancing, 10-turn dial indicator reads directly in units being measured
- Sensitivity: Measures resistance changes from 0.0002% to 8%
- Accuracy: 0.25%—independent of supply voltage variations
- Linearity: 0.1%
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- Response time: 4 secs. for 10-turn, full scale

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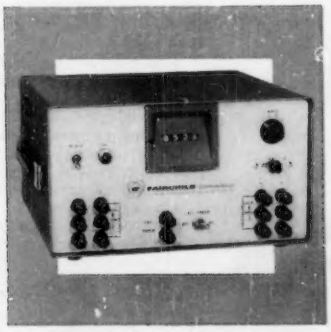

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(*Continued from page 108*)

**R. A. Wilkins,** Vice-President of Research and Development at Revere Copper and Brass, Inc., Rome, N. Y., was elected a fellow of the Institute of Metals, London, in recognition of outstanding services to the Institute as a corresponding member of the council in the United States. He is the first member resident outside the British Isles to be elected to the fellowship.

**Van Zandt Williams,** a Vice-President of Perkin-Elmer Corp., Norwalk, Conn., has been named General Manager of the company's newly formed Instrument Division.

**Wallace E. Wing** has been elected Chairman of the Board and Chief Operating Officer of Marblehead Lime Co., Chicago, Ill. Mr. Wing is active in Committee C-7 on Lime.

**Harry R. Wolf,** formerly of the Research Laboratories, General Motors Corp., Detroit, has retired because of illness. Mr. Wolf has been a member of ASTM since 1913 and very active in certain of the technical work of the Society, especially in Committees D-2 on Petroleum Products and Lubricants and D-15 on Engine Antifreezes, which he has headed since its organization in 1947. In recognition of valued service he was honored with a 1956 ASTM Award of Merit.

**Frank L. Wright,** formerly Consultant, Glenbrook, Conn., is now Director of Manufacture, Pneumafil Corp., Charlotte, N. C.

# NEW MEMBERS.....

*The following 187 members were elected from April 19 to June 13, 1956, making the total membership 8467 . . . . . Welcome to ASTM*

Note—Names are arranged alphabetically—company members first then individuals.—Your ASTM Year Book shows the areas covered by the respective Districts.

## CHICAGO DISTRICT

**Gaynes Engineering Co.,** C. S. Gaynes, Partner, 1642 W. Fulton St., Chicago 12, Ill.

**Arms, Richard W.,** Acme Resin Corp., 1401 Circle Ave., Forest Park, Ill.

**Baime, William B.,** Project Manager, Sobel and Stein, Architects, 450 E. Ohio St., Chicago, Ill. For mail: 8330 N. Ridgeway Ave., Skokie, Ill. [A]*

**Chang, Tien-Sun,** Instructor, University of Illinois, 107 Talbot Lab., Urbana, Ill. [A]

**Eby, Robert E.,** Chief Engineer, Rilco Laminated Products, Inc., W-2591 First National Bank Bldg., St. Paul 1, Minn.

**Groth, C. O.,** Director of Laboratory, J. I. Case Co., 700 State St., Racine, Wis.

**Habart, Herbert,** Chief Metallurgist, The Torrington Co., 3702 W. Sample St., South Bend 19, Ind. For mail: 1135 E. Bronson St., South Bend 15, Ind.

**Hine, Raymond F.,** Chief Metallurgist, Foundry, Studebaker-Packard Corp., 635 S. Main St., South Bend, Ind.

**Lendved, John W.,** Director of Engineering, Construction Machinery Div., Chain Belt Co., 4700 Greenfield Ave., Milwaukee 1, Wis.

**Longabaugh, John D.,** Chief Metallurgist, Johnson Motors Co., Lake Front, Waukegan, Ill.

**Matheis, Harry C.,** Vice-President, Houghton Vix-Syn Co., 130 Washington Ave., S., Hopkins, Minn.

**Tuckett, H. K.,** Planning Engineer, Plumb, Tuckett & Pikarsky, 2649 Wabash Ave., Gary 3, Ind.

**Wise, Robert S.,** Manager, Technical Service, National Aluminate Corp., 6216 W. 66th Pl., Chicago 38, Ill.

## CLEVELAND DISTRICT

**Basic, Incorporated,** Edward P. Pearson, Assistant Technical Director, 845 Hanna Bldg., Cleveland 15, Ohio.

**Hafner, R. H., Jr.,** Secretary, The Humphryes Manufacturing Co., 201 E. Fifth St., Mansfield, Ohio.

**Hazel, John J.,** Chief Ceramic Engineer, Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio.

**Husemann, E. W.,** Chief Metallurgist, Copperweld Steel Co., Warren, Ohio.

**Krumlauf, George,** Metallurgical Engineer, Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio.

**Neff, Charles Y.,** President, Neff-Perkins Co., 2130 St. Clair Ave., Cleveland 14, Ohio.

## DETROIT DISTRICT

**American Metal Products Co.,** G. K. Philip, Metallurgist, 5959 Linsdale Ave., Detroit 4, Mich.

**Austin, Donald C.,** Materials and Process Engineer, Automotive Body Div., Chrysler Corp., Detroit, Mich. For mail: 401 N. Vermont, Royal Oak, Mich.

**Cone, Carroll,** Chief Engineer, Surface Combustion Corp., Toledo 1, Ohio.

**Harton, John S.,** Field Electrochemist, Hanson-Van Winkle Munning Co., 100 Church St., Matawan, N. J. For mail: 4765 Tully Rd., R. D. #3, Bloomfield Hills, Mich.

(*Continued on page 112*)


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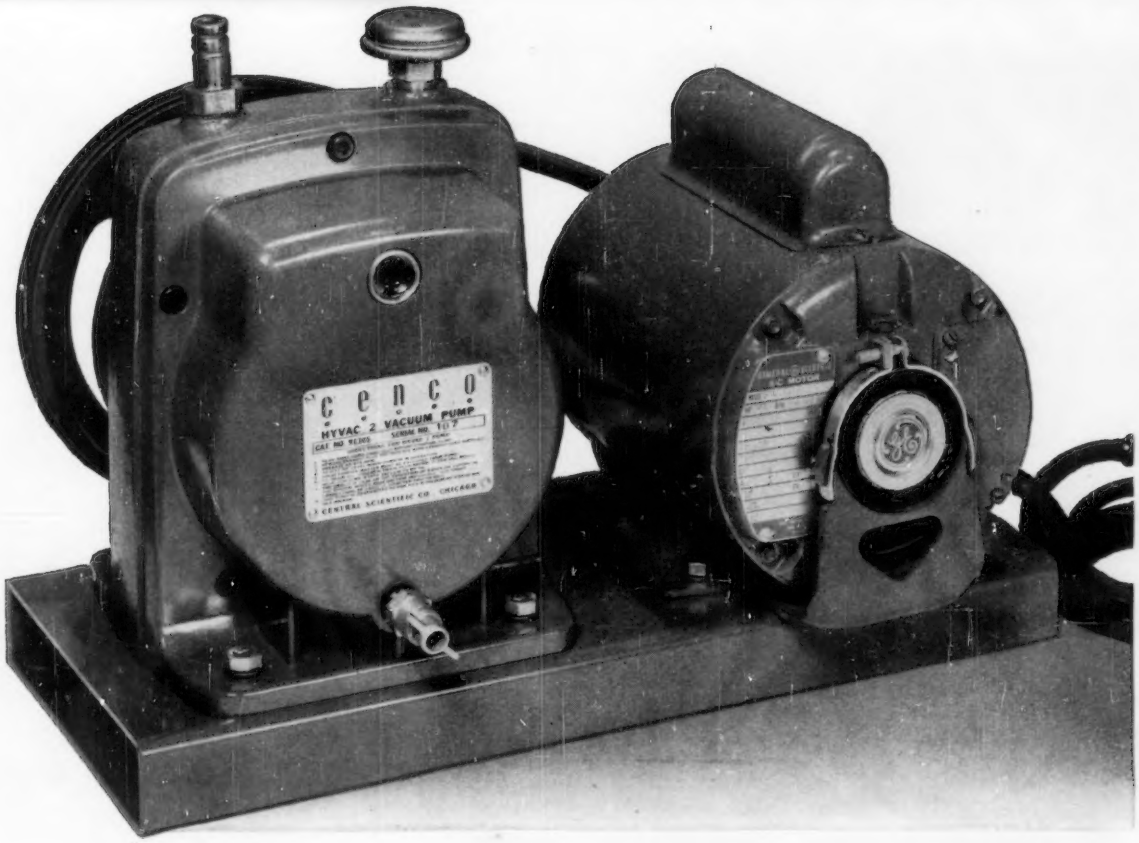


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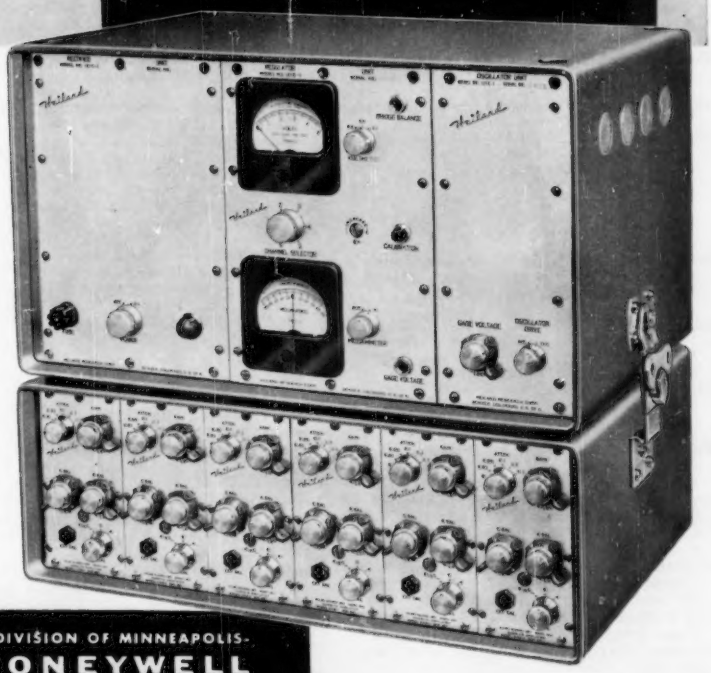

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**Laboratorio Central De Caminos,** Fernando Alva M., Jefe del Laboratoria Central, Chaeltana 136, Miraflores, Lima, Peru.

**Laur, August,** Polyethylen Unite, Diplom Organic Chemist, Carbide Chemical Co., Division of Union Carbide and Carbon Corp., 10555 St. Leonard Rd., Montreal, East, P. Q., Canada. For mail: 2495 Van Horne Ave. 15, Montreal, P. Q., Canada.

**Loera, R. Garcia,** Research Engineer, Cia. Minera Asarco, S. A., Parral, Chih., Mexico.

**Lovell, Edwin,** Director of Research, Alaska Pine and Cellulose, Ltd., Research Div., 8809 Heather St., Vancouver 15, B. C., Canada.

**MacFie, William Rustan,** Mechanical Engineer, Aktiebolaget Götaverken, Box 885, Gothenburg 8, Sweden.

**Padelletti, Guido,** Technical Manager, Bardahl Lubricants, Via Tornabuoni 1, Florence, Italy.

**Riedl, Josef,** Plant Manager, Schoeller-Bleckmann Stahlwerke AG., Forschungs- und Entwicklungsabteilung, Ternitz, N. O., Austria.

**Sesi, Salim D.,** Sindbad Hotel, Baghdad, Iran. [A]

**Stott, James B.,** Director, James Stott, Ltd., Werneth Mills, Oldham, Lancashire, England.

**Wellington City Corp.,** F. B. C. Jeffreys, City Engineer, Box 2199, Wellington, New Zealand.

* [A] denotes Associate members.
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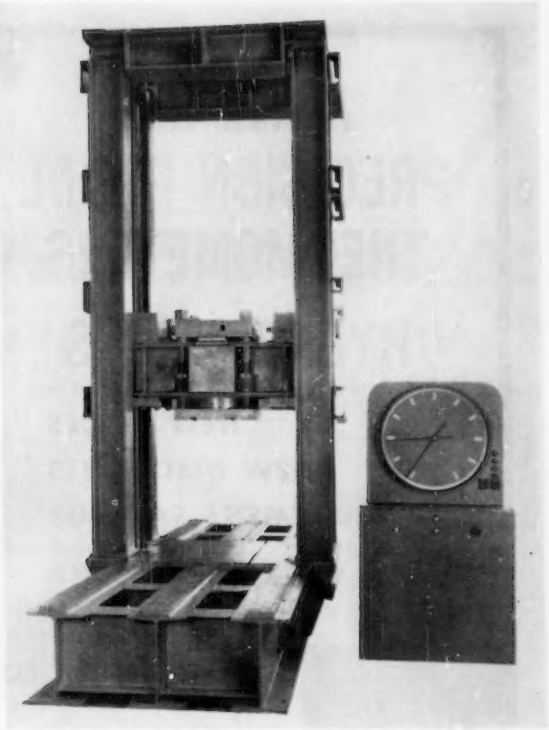

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| **Tension, Compression, Traverse, Fatigue—** | Young Universal Testing Machines cover a range of 1,000 lbs to 5,000,000 mechanically or hydraulically driven complete with all accessories. Machines for Torsion-Creep and Box testing. |
| **Thrust Photo-Elastic** | Young Thrust-Load Weighing Systems are available in pneumatic, hydraulic, or electrical models. Also color testing units. Photo-elastic machines with 8″ light fields. |
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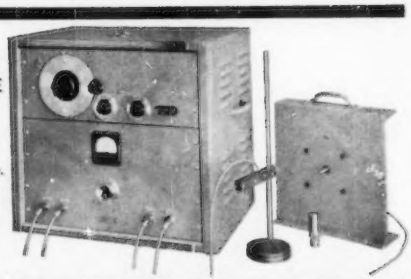

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## DEATHS...

**Frederick O. Anderegg,** research chemist and consultant on Building Materials, Somerville, N. J. (May 5, 1956). A graduate of Harvard University, Dr. Anderegg in his early years was on the faculties of the University of Illinois and Purdue University Department of Chemistry. He was senior industrial fellow, Mellon Institute from 1926 to 1930. Since 1930 he had been engaged as a consulting specialist on building materials. Affiliated with a number of technical societies he was the author of numerous papers concerned with lime, limestone, cement, mortars, concrete, brick walls, waterproofing, etc. A member of ASTM since 1929, Dr. Anderegg was very active in committees in the cementitious materials field, including C-1 on Cement, C-3 on Chemical-Resistant Mortars, C-7 on Lime, C-12 on Mortars for Unit Masonry, and C-15 on Manufactured Masonry Units, serving on many subgroups. He was an organizer of Committee C-3, and its first Chairman (1949–1952).

**Charles R. Austin,** assistant to the president, Mechanite Metal Corp., New Rochelle, N. Y. (May 31, 1956). Representative of company since 1948 on Committee A-3 on Cast Iron, serving for a time as Chairman of Subcommittee X on Nomenclature and Definitions.

**E. H. Beckstrand,** Professor of Mechanical Engineering (retired), University of Utah, Salt Lake City, Utah; residence, 244 Douglas St., Salt Lake City 2, Utah (February 24, 1956). Member of Society since 1907.

**Thomas A. Berrigan,** retired director and chief engineer, Massachusetts Sewerage Division, Metropolitan District Commission, Boston, Mass.; and consultant in law and engineering, Statler Office Building, Boston (May 11, 1956). Affiliated with ASTM since 1946, for many years as representative of the Sewerage Division, and more recently as a personal member, Mr. Berrigan had been a member of the New England District Council since 1951, being very interested in local ASTM activities, and looking forward to participation in the 1958 ASTM Annual Meeting scheduled to convene in Boston. A graduate of Massachusetts Institute of Technology, Harvard, and the Northeastern Law School, Mr. Berrigan was a lieutenant commander during World War II; had served as Assistant District Public Works Officer of the First Naval District, also as a member of the Water Pollution Control Advisory Board of the United States Public Health Service.

**Clinton T. Bissell,** consulting engineer, Committee on Construction of Buildings, National Board of Fire Underwriters, New York City; residence, 58 Cambridge Rd., Montclair, N. J. Member since 1929.

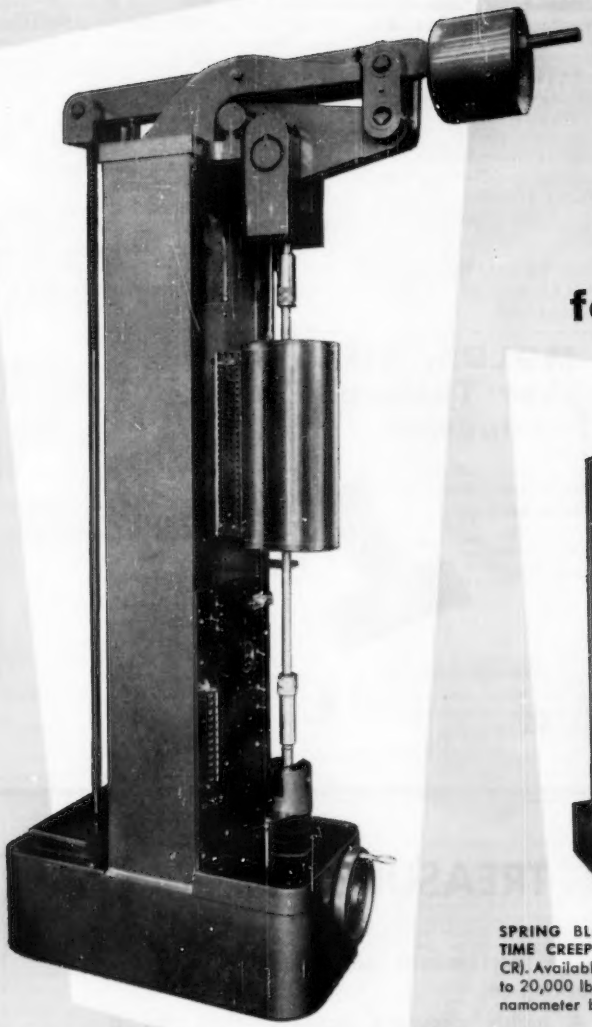
**A. Burton Cohen,** consulting engineer, 1 Madison Ave., New York City (February 11, 1956). Member since 1913.

**Paul H. Dike** (residence: 3619 Edencroft Road, Huntingdon Valley, Pa.), retired research consultant of Leeds & Northrup Co., Philadelphia, Pa., died June 25, 1956 at the age of 78 in Abington Memorial Hospital. Dr. Dike, a 1903 graduate of Northwestern University, received his doctorate in physics in 1911 from the University of Wisconsin. In his early years he was in charge of various magnetism observatories in this country and abroad. During World War I he was with the Army Signal Corps in Paris, also served as scientific attaché of the American Embassy in Paris. He was for varying periods on the faculties of Cornell College, University of Missouri, Roberts College (Constantinople) and Universities of North Carolina and Vermont. He joined Leeds & Northrop in 1925, becoming Assistant Director of Research in 1937, and retiring last year. He made many contributions to the development of resistors, alloys for scientific instrument use, the radiation-type detector for industrial temperatures, the L&N optical pyrometer and other instruments; and wrote extensively for scientific encyclopedias, textbooks and periodicals. In ASTM Dr. Dike represented his company for many years on a number of the technical committees, heading many subgroups, being especially active in Committees A-6 on Magnetic Properties and B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts. He was

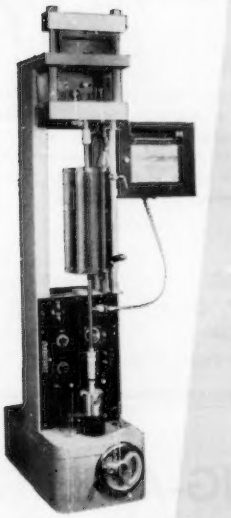
(*Continued on page 120*)

# 3 NEW MACHINES

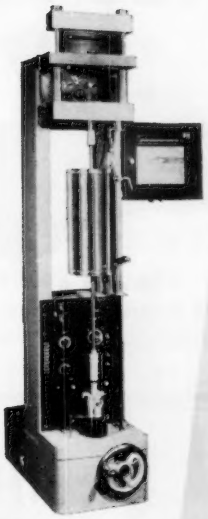
## for better creep testing



**LEVER TYPE FOR LONG-TIME CREEP TESTS.** Model CL-20 (20,000 lbs. capacity). Load applied by dead weights. Lever ratio of 40 to 1 means less lifting for operator. Automatic take-up keeps lever arm horizontal as specimen elongates. Specimen fracture produces minimum shock since weights are maintained a fraction of an inch above base. Accuracy within ½% of load or 0.1% of capacity.



**SPRING BLOCK TYPE FOR SHORT TIME CREEP RUPTURE TESTS.** (Model CR). Available in 5 capacities, from 1,000 to 20,000 lbs. Load applied through dynamometer by motor-driven screw jack.



**SPRING BLOCK TYPE MACHINE FOR AUTOMATIC CREEP RELAXATION TESTS.** Model CX-04 (4,000 lbs. capacity).

Only from Baldwin can you get exactly the right machine for each type of creep test. All three Baldwins are built on the same basic frame, so you can "convert" your machine by changing the head and accessories. Every Baldwin creep testing machine has these advantages:

- **It's compact. Requires less floor space than any other creep machine.**
- **All instrumentation is readable from front of machine.**
- **Recorder can be mounted on machine or on centralized panel board.**
- **Improved furnace provides more even heat distribution. Overload protection prevents burn-out.**
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- **Machine requires no special foundation, and need not be bolted to the floor.**
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also a member of the Philadelphia District Council.

**Flint C. Elder,** retired chief metallurgist and director of research, American Steel and Wire Corp., Cleveland, Ohio (January 15, 1956). Member of Society since 1910, serving for a number of years on Committees A-1 on Steel, A-5 on Corrosion of Iron and Steel, and B-2 on Non-Ferrous Metals and Alloys, also on the Cleveland District Council.

**Howard A. Gray,** engineer for many years with Jackson & Moreland, Somerville, Mass. (April 23, 1956). Member since 1926.

**Gilbert E. Kempka,** metallurgist, Johnson Motors, Waukegan, Ill. Member since 1955.

**R. E. McCurdy,** Hood Rubber Co. Division, The B. F. Goodrich Co., Watertown, Mass. (July 23, 1955). Representative of his company for a number of years on Committees D-11 on Rubber and Rubber-Like Materials, and D-21 on Wax Polishes and Related Material; member of New England District Council 1949–1951.

**E. W. McMullen,** partner, Ganteaume & McMullen, 99 Chauncey St., Boston, Mass. Member since 1945.

**Charles Nowell,** chief librarian, Reference Library, Manchester Public Libraries, Manchester, England. Representative of Libraries membership in Society for many years.

**E. N. Powell,** vice-president, Powell Brothers, Inc., Fort Lauderdale, Fla. (April 17, 1956). Member since 1952.

**C. C. Rose,** Willard Storage Battery Co., Cleveland, Ohio (December 16, 1955). Representative of company since 1938 on Committee D-11 on Rubber and Rubber-Like Materials and its Subcommittee XXIII on Hard Rubber.


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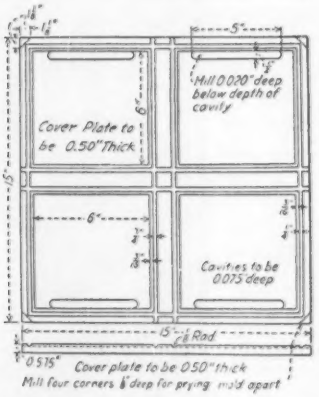
5"
Mill 0.020" deep below depth of cavity
Cover Plate to be 0.50" Thick
6"
Cavities to be 0.075 deep
0.515"
Cover plate to be 0.50" thick
Mill four corners ⅛" deep for prying mold apart

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## OTHER SOCIETIES' EVENTS

August 6–8—**Society of Automotive Engineers,** National West Coast Meeting, Mark Hopkins Hotel, San Francisco, Calif.

August 20–21—**Institute of Radio Engineers-American Institute of Electrical Engineers-Institute of Aeronautical Sciences,** National Telemetering Conference, Statler Hotel, Los Angeles, Calif.

August 20–24—**Gordon Research Conference on Infra-Red Spectroscopy,** Kimball Union Academy, Meriden, N. H.

August 21–24—**Western Electronic Show and Convention,** Ambassador Hotel and Pan Pacific Auditorium, Los Angeles, Calif.

August 27–31—**Gordon Research Conference on Adhesion,** New Hampton School, New Hampton, N. H.

September 7–10—**American Statistical Association,** Annual Meeting Section on Physics and Engineering Sciences, Hotel Sheraton-Cadillac, Detroit, Mich.

September 9–12—**American Institute of Chemical Engineers,** Meeting, Wm. Penn Hotel, Pittsburgh, Pa.

September 10–12—**American Society of Mechanical Engineers,** Fall Meeting, Cosmopolitan Hotel, Denver, Colo.

September 13–15—**American Assn. Textile Chemists and Colorists,** Annual Meeting, Hotel Waldorf-Astoria, New York, N. Y.

September 16–21—**American Chemical Society,** Fall Meeting, Atlantic City, N. J.

September 17–21—**Illuminating Engineering Society,** National Technical Conference, Hotel Statler, Boston, Mass.

September 17–21—**Instrument Society of America,** Annual Instrument-Automation Conference and Exhibit, New York Coliseum, New York, N. Y.

September 24–26—**American Rocket Society,** Fall Meeting, Buffalo, N. Y.

September 24–26—**American Oil Chemists Society,** Fall Meeting, Sherman Hotel, Chicago, Ill.

September 24–26—**The Atomic Industrial Forum, Inc.,** Annual Meeting and Trade Fair of the Atomic Industry, Morrison Hotel and Navy Pier, Chicago, Ill.

September 25–28—**Assn. of Iron and Steel Engineers,** Annual Convention and Exposition, Hotel Statler and Cleveland Public Auditorium, Cleveland, Ohio.

September 30–October 4—**Electrochemical Society,** Hotel Statler, Cleveland, Ohio.

October 1–3—**National Electronics Conference,** Chicago, Ill.

October 1–5—**American Institute of Electrical Engineers,** Fall Meeting, Hotel Morrison, Chicago, Ill.

October 2—**American Society of Naval Engineers,** Annual Meeting, Washington, D. C.

October 3–5—**Standards Engineers Society,** Annual Meeting, Willard Hotel, Washington, D. C.

October 7–12—**Society of Motion Picture and Television Engineers,** 80th Convention, Ambassador Hotel, Los Angeles, Calif.

October 8–10—**American Institute of Mining and Metallurgical Engineers,** Institute of Metals Meeting, Allerton Hotel, Cleveland, Ohio.

October 8–12—**American Welding Society,** National Fall Meeting, Hotel Cleveland, Cleveland, Ohio.

October 15–17—**American Society of Civil Engineers,** Annual Meeting, Hotel Wm. Penn, Pittsburgh, Pa.


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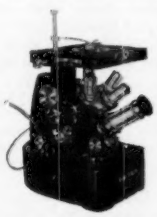
| Northwestern Univ. | Owens-Corning Fiberglas |
| Goodyear Atomic Corp. | Battelle Memorial Institute |
| Corn Products Refining | United Aircraft Corp. |



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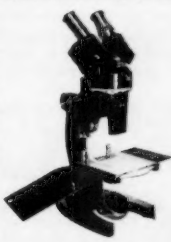

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# NEWS NOTES ON
# Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The society is not responsible for statements advanced in this publication.

## NEW PRODUCTS

**Spectrophotofluorometer**—Ideal for quantitative assay, fluorescent analysis, and identification of compounds in solution throughout the visible and ultraviolet regions.
*American Instrument Co., Inc.* 1129

**Creep Rupture**—A new multiple creep-rupture testing machine of the lever type in which four specimens can be held simultaneously under loads up to 4000 lb.
*Baldwin-Lima-Hamilton Corp.* 1130

**High Frequency Load Cell**—To measure the extremely high frequency variations of thrust imparted by explosive reactions of solid propellant rockets, a special transducer of force has been produced to measure a 20,000-lb thrust in 3 microseconds with maximum deflection of only 0.0005 in. under full load. This provides a natural mechanical frequency response of about 1900 cps, claimed to be more than twice that of any previous cells.
*Baldwin-Lima-Hamilton Corp.* 1131

**Gas Chromatography**—A new instrument for gas and vapor-phase chromatography offers fast and accurate analysis of gases or liquids, even liquids boiling up to 300 C. Smaller and compact it may be bench-mounted or panel-mounted for process control.
*Burrell Corp.* 1132

**Potentiometer**—Improved ¼ in. diameter trimmer potentiometer.
*Carter Mfg. Corp.* 1133

**Pressure Reducing, Regulative Valve**—Addition of a new small size pressure reducing and regulating valve to line of automatic valves, controllers, governors, and regulators.
*A. W. Cash Co.* 1134

**Dynamometers**—New push pull dynamometers are the only dial scales wherein push and pull can be measured from the same shaft.
*John Chatillon & Sons* 1135

**Pressure Pickup**—New pressure pick-up, which more than doubles the existing temperature range for this type of transducer.
*Consolidated Electrodynamics Corp.* 1136

**50,000-lb Force Gage**—Available for either compressive or tensile tests and has a warranted accuracy of within 1 per cent of the indicated reading.
*W. C. Dillon & Co.* 1137

**Faster Industrial X-Ray Film**—New industrial X-ray film, Type AA, which retains fine sensitivity with greatly reduced exposure needs.
*Eastman Kodak Co.* 1138

**Dynamic Conductance Tube & Transistor Tester**—For color and monochrome TV servicing. Claims speedy, simple operation, close simulation of actual tube operating conditions, sensitivity and accuracy of test and ruggedness.
*Electronic Instrument Co., Inc.* 1139

**Demineralized Water**—Low cost demineralized soft water, equivalent in ionic purity and softness to triple distilled water, is now available right from the tap with the new "Pup."
*Enley Products, Inc.* 1140

**Tera-Ohmmeter**—For resistance measurements up to 500 million megohms.
*Federal Telephone & Radio Co.* 1141

**Ultra-safe Carton**—Reagents will now be available in cases containing 4 one-gallon bottles, *each in its own individual factory-sealed two-layered, double-corrugated carton.*
*Fisher Scientific Co.* 1142

**Blast Burner** — Accident-proof, completely noiseless, completely controllable blast-burner for laboratory work.
*Fisher Scientific Co.* 1143

**Cathode Ray Tube**—New cathode-ray tube, can capture and retain visual displays of transients without resorting to photography.
*Hughes Aircraft Co.* 1144

**Lead Comparator**—A bench model lead comparator, capable of measuring the lead of threads in larger diameters and in longer lengths.
*Jerpbak-Bayless Co.* 1145

**Aniline Apparatus**—Automatic aniline apparatus has been designed to eliminate the long-used, time-consuming, tedious, and repetitious way of arriving at the aniline, or mixed aniline point of a sample.
*Koehler Instrument Co., Inc.* 1146

**Multi-Dialyzer for Fixed Volume and Continuous Flow**—Designed for rapid mechanical dialyzate and buffer or by continuous flow. Manufacturer claims it shortens this tedious process from two or three days to less than two hours. 1147
*Laboratory Glass & Instruments Corp.*

**Balance**—Between two and four seconds is the normal weighing time with automatic self-balancing scale.
*Arthur S. LaPine & Co.* 1148

**Hydrogen Determinator**—Only 20 minutes to determine hydrogen content in most metals and alloys.
*Ledoux & Co.* 1149

**New Furnace**—Designed for many critical temperature heat-treating operations such as annealing large intricate assemblies of laboratory glass, production heat-treating metal, etc., where furnace gradients must be controlled closely. Interior dimensions are 24 in. wide by 24 in. high from hearth to roof and 72 in. long. Completely automatic control.
*L & L Mfg. Co.* 1150

**Differential Refractometer** — Recording differential refractometer for continuous analysis of binary-liquid streams.
*Manufacturers Engineering & Equipment Corp.* 1151

**Interlock Switch**—Subminiature door interlock switch, for use on radio, radar, X-ray, and other hazardous high-frequency equipment cabinets. 1152
*Minneapolis-Honeywell Regulator Co.*

**Weight Sets**—Availability of a new line of weights contained in Sto-A-Weigh boxes, affording every laboratory the advantage of having their weights in a hinged covered box, thus assuring the retention of the accuracy for a longer period of time.
*Ohaus Scale Corp.* 1153

**Compression Tester** — 500,000-lb capacity compression testing machine built specifically for testing complete aircraft wheel assemblies is designed so that any one of three testing ranges—full capacity, 1/5 capacity and 1/20 capacity—are instantly available without stopping the test.
*Tinius Olsen Testing Machine Co.* 1154

**Timer**—Electronic timer which provides electronically accurate repeat timing without resetting.
*Photo Materials Co.* 1155

**Aquatrator**—Rapid, accurate determinations of moisture in a wide range of chemicals (both solid and liquid), foods, drugs, and industrial products.
*Precision Scientific Co.* 1156

**Fineness Tester**—Designed primarily for determining the fineness of Portland Cement in accordance with ASTM Method C 204, the Blaine air permeability fineness tester is currently being employed to study the fineness characteristics of pharmaceutical powders and other granular materials.
*Precision Scientific Co.* 1157

**Revolving Shelf Oven**—Especially suitable for determining loss-on-heating of oils or asphaltic compounds according to ASTM Method D-6 and A.A.S.H.O. Method T-47 as well as any other tests requiring a slowly rotating inner shelf and

a temperature range of 35 to 180 F with stringent temperature control of ±1 F.
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**Precision Laboratory Evaporator**—Combining simplicity of design and compactness with a larger capacity and rate of operation than found in units heretofore available. Evaporator is claimed effective for concentrating and separating a wide range of products, including sugar syrup solution, fruit juices, gelatin liquors, aqueous or alcoholic solutions, wheat residues and similar products.
*Precision Scientific Co.* 1159

**Astatic Wattmeters, Voltmeters, Milliameters**—These instruments should be of particular interest to engineers where power supplies operate at 400 to 1000 cps.
*Rawson Electrical Instrument Co.* 1160

**Gram Gage**—For measuring minute pressures within the range of 0.5 to 5 g.
*George Scherr Co., Inc.* 1161

**Pocket Penetrometer**—Pocket penetrometer for field and laboratory classification of soils.
*Soiltest, Inc.* 1162

**Steel Standards**—Set of steel standards for spectrochemical and wet chemical standardization.
*Spex Industries, Inc.* 1163

**Flatness**—Mono-light developed to give precision measurement of flatness.
*Spitfire Tool Co.* 1164

**Fine Grinding**—An improved series of fluid jet grinding machines, designed to reduce solids to particles in the micron range at a solid feed rate of up to 1.5 tons an hour.
*Sturtevant Mill Co.* 1165

**Sub-Zero Cabinet**—Economical 2-ft sub-zero cabinet offers −140 F temperature top or front opening.
*Webber Engineering Co.* 1166

## CATALOGS AND LITERATURE

**Analog**—Eight-page bulletin describing new 13-digit and 16-digit optical-type analog to digital angular position encoders.
*The Baldwin Piano Co., Electronics Div.* 2074

**Thermocouple Data Book**—*Bulletin F-5228-3* discusses construction and application of thermocouples and radiation detectors as used on industrial control applications.
*Barber-Colman Co.* 2075

**Self Operating Temperature Regulator**—A new bulletin with complete information on a self operating temperature regulator is now available.
*A. W. Cash Co.* 2076

**Balances**—A new, illustrated booklet containing a complete selection of laboratory balances and weights.
*Central Scientific Co.* 2077

**Laboratory Apparatus**—*Cenco News Chats* Number 82, contains descriptions and photos of new and redesigned instruments and apparatus for laboratory use including a refrigerating incubator, vacuum pumps, pump plates for vacuum evaporation, projection meter, a new line of all metal ovens, and many others.
*Central Scientific Co.* 2078

**Phenolics**—*Celoron Catalog C-56* gives complete and up-to-date technical information and various specification tables.
*Continental-Diamond Fibre* 2079

**Distillation "Do-It-Yourself"**—Complete assembly of unitized, interchangeable parts for research and industrial distillation; all you need is a wrench, a screwdriver, and 4 hours; all parts are standard. (*Bulletin FS-256.*)
*Fisher Scientific Co.* 2080

**Viscosimeter**—(*Bulletin FS-261*) describes the newest model of the Saybolt Viscosimeter produced by Fisher/Tag (Petroleum instruments) division of *Fisher Scientific Co.*
*Fisher Scientific Co.* 2081

**Spec-Lab.**—8-page, two color catalog illustrating and describing the Spec-Lab, a low cost, high precision industrials spectrograph
*Jarrell-Ash Co.* 2082

**Furnaces**—Catalog describing our standard and special Furnaces to 3000 F in several series.
*L & L Mfg. Co.* 2083

(*Continued on page 124*)


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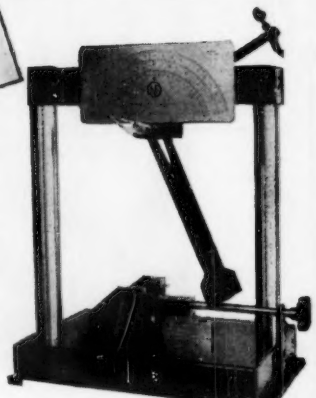

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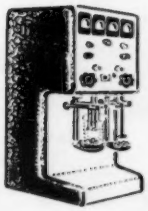

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(Continued from page 123)

**Electronic Temperature Controller**—*Specification Sheet S1010-1* describes a nonindicating device, which operates on the balanced bridge principle. 2084
*Minneapolis-Honeywell Regulator Co.*

**Water-Cooler**—New bulletin, with engineering data on a new water cooler designed for use with X-ray diffraction instruments.
*North American Philips Co., Inc.* 2085

**Scintillation Detectors**—Latest issue of the *Nucleus* describes a new line of radioactivity detecting scintillation counters.
*Nuclear Instrument & Chemical Corp.* 2086

**Machine Maintains Fixed Extension**—An automatic testing machine for maintaining a fixed tension or strain when testing at elevated temperatures.
*Tinius Olsen Testing Machine Co.* 2087

**Chromatography**—*Binder No. 1* describes three new models of the vapor-phase chromatographic apparatus.
*Podbielniak, Inc.* 2088

**Flash Testers**—*Bulletin 737* on the redesigned gas or electric heat Pensky-Martens Flash Testers which are standard for ASTM, U. S. Government and British Institute specifications pertaining to the testing of fuel oils and cutback asphalts.
*Precision Scientific Co.* 2089

**Gum Content**—*Bulletin 756* on two unit bath for measuring existent gum content in gasoline.
*Precision Scientific Co.* 2090

**Automatic Distillation apparatus**–for products having a boiling range between 90 and 700 F.
*Precision Scientific Co.* 2091

**Stirrer**—*Bulletin 738* on the Slo-Speed Stirrer which was specially developed for use in flash point tests and other laboratory procedures requiring stirring at a slow, constant speed.
*Precision Scientific Co.* 2092

**Chromatography and Electrophoresis**—36-page catalog on *Apparatus and Accessories of Chromatography and Electrophoresis.* 2093
*Scientific Glass Apparatus Co., Inc.*

**Torque Manual**—Second edition of *Torque Manual* has been materially expanded and now includes additional torque application formulas.
*P. A. Sturtevant Co.* 2094

**Explosion Chamber**—Four-page folder describing an advanced-design explosion chamber.
*Tenney Engineering, Inc.* 2095

**Testing**—*Leaflet P-560* contains illustrations and brief descriptions of 31 instruments for testing paper, plastics, textiles, light metals, and other materials.
*Thwing-Albert Instrument Co.* 2096

**Graphite Boats, Crucibles and Funnels**—*Catalog Section 456* with extensive information on High Purity Graphite Boats, Crucibles and Funnels.
*United Carbon Products Co., Inc.* 2097

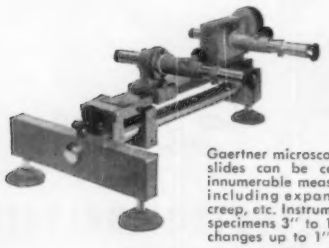
## INSTRUMENT COMPANY NEWS

**Beckman Instruments, Inc., Fullerton, Calif.**—Ground was broken March 6 on a picturesque ocean-view site in Newport Beach for the two-million-dollar plant Beckman Instruments, Inc., will build for its Helipot Division, a leading manufacturer of precision electronic components.

**Hallikainen Instruments, Berkeley, Calif.**—Hallikainen Instruments is pleased to announce the near completion of an expansion program that will make available 6500 square feet of space—an increase of approximately 150 per cent over its present facilities—for the manufacture of industrial and scientific instruments.

**Minneapolis-Honeywell Regulator Co., Freeport, Ill.**—Glenn E. Seidel has been appointed to the newly created corporate position of vice-president in charge of engineering for Minneapolis-Honeywell Regulator Company. Seidel has been a member of Honeywell's extensive engineering organization for nearly 14 years and since 1952 has been vice-president in charge of engineering in the firm's Minneapolis plants.

**Tenney Engineering, Inc., Union, N. J.**—Leading manufacturer of environmental test and refrigeration equipment, has just announced the establishment of a separate engineering section that will offer consultation service on the design of new environmental test chambers and the modification of existing equipment. Mr. Robert H. Brown, Tenney's vice-president, has been named to head this new section.

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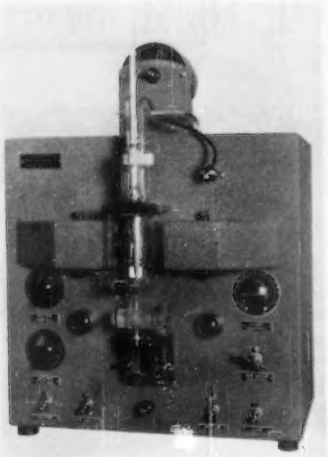

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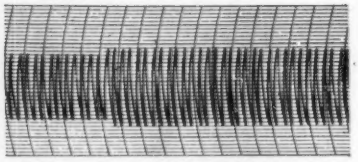
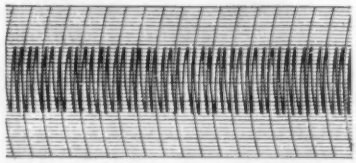


Output of typical electromechanical regulator in response to step change in input voltage. Average correction rate of 6v. per sec.



Output of Curtiss-Wright Distortion Eliminating Voltage Regulator from same input. Full recovery in 330 microsec.

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- **Electronically regulates r.m.s. and peak voltage simultaneously to ±1%.**
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## ASME–ASLE Lubrication Conference

PRELIMINARY plans for the third jointly sponsored Lubrication Conference which will be held at Chalfonte-Haddon Hall in Atlantic City October 8–10, indicate that special attention will be given to problems involved in the lubrication of nuclear power equipment. Eight research papers in this field range from studies of fluid metal as lubricants to the effect of radiation on petroleum products.

Another highlight of the Conference will be a "reporter type" session devoted to papers on hydrodynamic lubrication. This type of meeting assumes that the papers will have been read and studied prior to their presentation and consequently only a synopsis of each paper will be given by a reporter. It is expected that most of the session will be devoted to discussions and the authors' closures.

Other subjects that will be covered include boundary lubrication and lubricants. Approximately 22 research and development papers will be presented during the conference period.

As in previous conferences, there will be no conflicting sessions, and those attending will have the opportunity to hear the presentation of all papers. The practice of providing registrants with preprints of the papers to be presented will be continued.

## Bibliography on Air Pollution

THE Library of Congress has agreed to prepare a continuing, annotated bibliography on air pollution which will include references to the physical, biological, engineering, legal-administrative, and economic aspects of atmospheric pollution.

This is the fourth agreement the Public Health Service has negotiated with other Federal agencies under the terms of Public Law 159 of the present Congress. Last year, Congress appropriated $1,785,000 for Public Health Service support of air-pollution research and technical assistance. In December, HEW announced that the Bureau of Mines, Department of the Interior, and the National Bureau of Standards and the Weather Bureau, Department of Commerce, would undertake research projects in air-pollution aspects for the Public Health Service.

## Cellulose Concrete

DURING recent years the increasing interest of American industry in the manufacture and use of cellular concretes has led the National Bureau of Standards to study the properties and composition of these lightweight construction materials. Low density of cellular concretes is attained by the incorporation of a homogeneous void or cell structure throughout the material. The voids may occupy from 25 to 75 per cent of the total volume of the hardened concrete, and the density of the concrete may range from less than 20 to more than 100 lb per cu ft. Most of the European cellular concretes weigh 25 to 50 lb per cu ft, however, or about $\frac{1}{4}$ to $\frac{1}{3}$ as much as ordinary concrete.

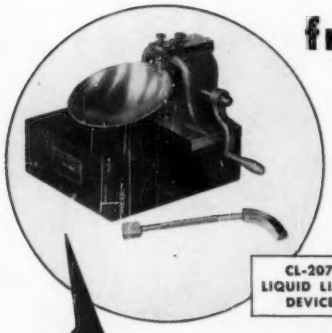
The production of moist-cured and high-pressure steam-cured precast products of cellular concrete has grown rapidly in Europe in the past 20 years. In Sweden the annual production of precast elements exceeds 1 million cu yd. Most of the structurally important types of cellular concrete products have consisted of precast roof plank, block, beams, and other elements, and all have been cured in high-pressure steam autoclaves.

Three methods used for producing the cell structure are: (1) mechanical—whereby the air is entrained in the mixture by the high-speed mixing of a cementitious slurry with a foaming or air-entraining agent; (2) chemical—mixtures that react chemically with each other to generate uniformly distributed gas bubbles; and (3) excess water—a thin slurry is prepared from finely divided cementitious and aggregate materials.

For a given weight the autoclaved cellular concretes have a greater strength; and essentially complete development of strength may be obtained in less than one day. The steam pressure in the autoclave is usually in the range of 120 to 160 psi at 350 to 370 F, maintained for 6 or more hours. During autoclaving, the siliceous or pozzolanic material reacts with hydrated lime in the presence of moisture to form calcium silicates that have relatively low drying shrinkage and high strength. The reactions involved are similar to those occurring in sand-lime brick, also cured in high-pressure steam.

Some industrial wastes abundant in this country are high in silica and alumina and include fly ash from coal-burning power plants and from kilns producing expanded lightweight aggregates made from shale, slate, and clay. Some of these materials were used with portland cement in autoclaved cellular concretes prepared at the National Bureau of Standards. Commercial European products are made with lime or portland cement and burnt oil shale, ground silica sand, fly ash, or other pozzolanic material. Both the European commercially made materials and those prepared at the Bureau had, at a density of 35 to 50 lb per cu ft, compressive strengths of 300 to more than 2000 psi, flexural strengths of $\frac{1}{7}$ to $\frac{1}{5}$ of these values, and drying shrinkages of 0.02 to 0.10 per cent, depending upon the nature and proportions of cementitious and pozzolanic ingredients.

Nonautoclaved cellular concretes containing nonaggregate have developed 0.3 to 0.6 per cent linear drying shrinkage and 200 to 400 psi 28-day compressive strengths at dry densities of 30 to 40 lb per cu ft. Cement-sand mixtures (1 to 4 by weight) weighing 70 to 90 lb per cu ft had 28-day strengths of 250 to 800 psi and shrinkages of 0.08 to 0.20 per cent. In addition to the advantage of light weight, cellular concretes have relatively high thermal insulation values—10 to 15 times that of commonly used sand-gravel concretes.

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A constant volume of air at a controlled temperature in the heavily insulated cabinet, maintains uniform predetermined specimen temperatures regardless of variations in room conditions.

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Source of radiation is two Atlas enclosed violet carbon arcs.

Complete technical information on the DMC Model and other Weather-Ometers is contained in the new Weather-Ometer catalog. Copy on request.

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The Atlas Fade-Ometer has world-wide acceptance as the standard machine for testing the action of sunlight on materials.

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The Carbon Arc Lamp in the Fade-Ometer is the closest known duplicate of sunlight, both as to intensity and spectral distribution.

If your product is subject to deterioration by sunlight our engineers, with over a quarter of a century of experience in predetermining the fading of materials, can help you.

*Catalog with technical information on request*

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*Card valid until Feb. 1, 1957*

**Advertised Products**

| | | | | | | |
|---|---|---|---|---|---|---|
| 215 | 216 | 217 | 218 | 219 | 220 | 221 |
| 222 | 223 | 224 | 225 | 226 | 227 | 228 |
| 229 | 230 | 231 | 232 | 233 | 234 | 235 |
| 236 | 237 | 238 | 239 | 240 | 241 | 242 |
| 243 | 244 | 245 | 246 | 247 | 248 | 249 |
| 250 | 251 | 252 | 253 | 254 | 255 | 256 |

**New Products Section: page 122**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1135 |
| 1136 | 1137 | 1138 | 1139 | 1140 | 1141 | 1142 |
| 1143 | 1144 | 1145 | 1146 | 1147 | 1148 | 1149 |
| 1150 | 1151 | 1152 | 1153 | 1154 | 1155 | 1156 |
| 1157 | 1158 | 1159 | 1160 | 1161 | 1162 | 1163 |
| 1164 | 1165 | 1166 | | | | |

**Catalogs and Literature Section: page 123**

| | | | | | | |
|---|---|---|---|---|---|---|
| 2074 | 2075 | 2076 | 2077 | 2078 | 2079 | 2080 |
| 2081 | 2082 | 2083 | 2084 | 2085 | 2086 | 2087 |
| 2088 | 2089 | 2090 | 2091 | 2092 | 2093 | 2094 |
| 2095 | 2096 | 2097 | | | | |

Please send me more complete information on the products represented by numbers circled above.

Name_____

Title_____

Company_____

Product_____

Address_____

City and Zone_____ State_____

# *Definitions of terms . . .*

Standardized by ASTM, widely used by Industry, and often the authoritative references used by courts of law in settling disputes.

| | Price |
|---|---|
| Definitions of Terms Relating to Wrought Iron (A 81) | .30 |
| Definitions of Terms Relating to Cast Iron (A 196) | .30 |
| Definitions of Terms, with Symbols, Relating to Magnetic Testing (A 340) | .30 |
| Methods and Definitions for Mechanical Testing of Steel Products (A 370) | .50 |
| Classification of Cast Copper-Base Alloys (B 119) | .30 |
| Classification of Coppers (B 224) | .30 |
| Definitions of Terms Used in Powder Metallurgy (B 243) | .30 |
| Definitions of Terms Relating to Gypsum (C 11) | .30 |
| Classification of Fireclay Refractories (C 27) | .30 |
| Definitions of Terms Relating to Structural Clay Tile (C 43) | .30 |
| Definitions of Terms Relating to Lime (C 51) | .30 |
| Definition of the Term Sand and Definition of the Term Aggregate (C 58) | .30 |
| Definitions of Terms Relating to Refractories (C 71) | .30 |
| Symbols for Heat Transmission (C 108) | .30 |
| Definition of Terms Relating to Natural Building Stones (C 119) | .30 |
| Definition of Terms Relating to Concrete and Concrete Aggregates (C 125) | .30 |
| Classification of Insulating Fire Brick (C 155) | .30 |
| Definition of Terms Relating to Glass and Glass Products (C 162) | .30 |
| Definitions of Terms Relating to Thermal Insulating Materials (C 168) | .30 |
| Definition of Terms as Applied to Hydraulic Cement (C 219) | .30 |
| Definitions of Terms Relating to Ceramic Whitewares (C 242) | .30 |
| Definitions of Terms Relating to Structural Sandwich Constructions (C 274) | .30 |
| Definitions of Terms Relating to Porcelain Enamel (C 286) | .30 |
| Descriptive Nomenclature Constituents of Natural Mineral Aggregates (C 294) | .30 |
| Classification of Single- and Double-Screened Ground Refractory Materials (C 316) | .30 |
| Definitions of Terms Relating to Materials for Roads and Pavements (D 8) | .30 |
| Definitions of Terms Relating to Timber (D 9) | .30 |
| Definition of Terms Relating to Paint, Varnish, Lacquer, and Related Products (D 16) | .30 |
| Definitions of Terms Relating to Coal and Coke (D 121) | .30 |
| Definitions of Terms Relating to Textile Materials (D 123) | .60 |
| Definitions of Terms Relating to Petroleum (D 288) | .30 |
| Definitions of Terms Relating to Timber Preservatives (D 324) | .30 |
| Definition of the Terms Gross Calorific Value and Net Calorific Value of Solid and Liquid Fuels (D 407) | .30 |
| Definition of Terms Relating to Soaps and Other Detergents (D 459) | .30 |
| Definition for Commercial Varieties of Bituminous and Subbituminous Coals (D 493) | .30 |
| Definitions of Terms and Symbols Relating to Soil Mechanics (D 653) | .30 |
| Nomenclature of Descriptive Terms Pertaining to Plastics (D 675) | .30 |
| Definitions of Terms Relating to Naval Stores and Related Products (D 804) | .30 |
| Definitions of Terms Relating to Plastics (D 883) | .30 |
| Definitions of Terms Relating to Adhesives (D 907) | .30 |
| Classification of Diesel Fuel Oils (D 975) | .30 |
| Recommended Code for Designating Form of Material and Direction of Testing Plastics (D 1009) | .30 |
| Definition of Terms Relating to Shipping Containers (D 996) | .30 |
| Definitions of Terms Relating to Veneer and Plywood (D 1038) | .30 |
| Definitions of Terms Relating to Bituminous Waterproofing and Roofing Materials (D 1079) | .30 |
| Definitions of Terms Relating to Industrial Water (D 1129) | .30 |
| Nomenclature of Domestic Hardwoods and Softwoods (D 1165) | .30 |
| Definitions and Specifications for Farm Tractor Fuels (D 1275) | .30 |
| Definitions of Terms Relating to Atmospheric Sampling and Analysis (D 1356) | .30 |
| Definitions of Terms Relating to Methods of Mechanical Testing (E 6) | .30 |
| Definitions of Terms Relating to Metallography (E 7) | .30 |
| Definitions of Terms Relating to Specific Gravity (E 12) | .30 |
| Definition of the Term Screen (Sieve) (E 13) | .30 |
| Definitions of Terms Relating to Rheological Properties of Matter (E 24) | .30 |
| Definitions with Procedures Relating to Conditioning and Weathering (E 41) | .30 |
| Definitions of Terms Relating to Heat Treatment of Metals (E 44) | .30 |
| Industrial Radiographic Terminology for Use in Radiographic Inspection of Castings and Weldments (E 52) | .30 |
| Recommended Practice for Radiographic Testing (E 94) | .30 |
| A glossary of terms is appended to the "Manual on Industrial Water," *STP 148A* | 5.00 |
| Glossary of Terms Relating to Rubber and Rubber-Like Materials—*STP 184* | |

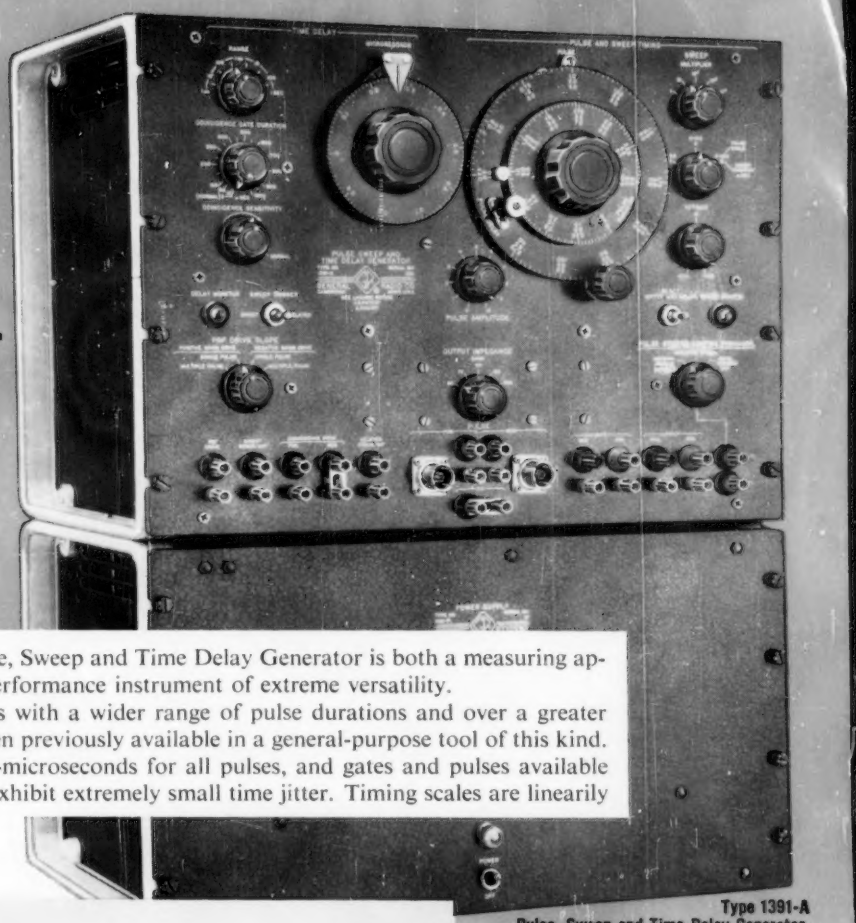
*. . . available from*

**American Society for Testing Materials**

1916 Race Street Philadelphia 3, Pa.

# Pulse Generator
# Time-Delay Generator
# Sweep Generator

*The Most Complete Time-Domain Measuring Instrument Ever Offered!*



The new G-R Type 1391-A Pulse, Sweep and Time Delay Generator is both a measuring apparatus and generator . . . a high-performance instrument of extreme versatility.

This equipment generates pulses with a wider range of pulse durations and over a greater range of repetition rates than has been previously available in a general-purpose tool of this kind. Rise and fall times average 25 milli-microseconds for all pulses, and gates and pulses available at the output are highly stable and exhibit extremely small time jitter. Timing scales are linearly calibrated and accurate to 1%.

Available at the instrument's various binding posts are:

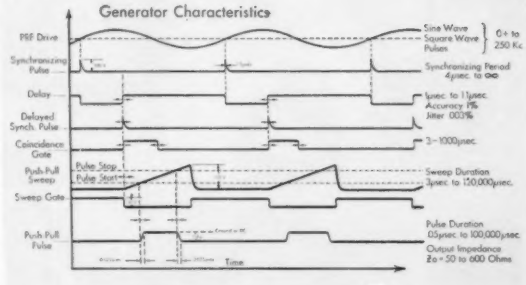
**A direct-trigger pulse** ( or synchronizing pulse) timed by the input signal.

**A delayed synchronizing pulse** accurately adjustable in time by the delay generator — to perform time selection, built-in coincidence circuitry permits timing of the delayed synchronizing pulse to be controlled by externally generated pulses fed into the instrument.

**A push-pull sawtooth voltage** of sufficient amplitude to be appiled to the deflection plates of any oscilloscope for examing the generator's output pulses, or for use in driving auxiliary equipment.

**A push-pull gating pulse** having the same duration as the sweep.

**Positive or negative pulses** with excellent shape characteristics, continuously adjustable in duration, amplitude, and delay with respect to (a) the input trigger and (b) the sweep, at a variety of output impedances.




**Type 1391-A**
**Pulse, Sweep and Time-Delay Generator, complete with Power Supply . . . $1745.**

**Pulse Timing**

A switch and binding posts are included . . .

- to make available to the user the accurately timed pulses (not shown on diagram) which start and stop the main pulse.
- to permit the user to start and stop the main pulse with timing pulses generated external to the instrument; under such operation the maximum pulse repetition rate can be extended to several Mc.

**Input System:**
Accepts sine or square wave of 0.5v, p-to-p, or pulses of 10v, p-to-p, from external source to form a direct-trigger pulse.

**Direct Synchronizing Pulse:**
From cathode follower, positive, over 80 volts in amplitude, 1 μsec duration.

**Main Delay Circuit:**
**Range** — 1 μsec to 1.1 sec in six ranges.
**Absolute Accuracy** — 2%; Incremental Accuracy ±(1% + .05 μsec).
**Resolution** — 1 in 8800
**Stable** — against hum and line transients to better than one part in 10,000 at all time delays.
**Duty Ratio Effects**—Less than 2% error at 90% duty-ratio.
**Delay Repetition Rate** — 0 to 400 kc.

**Coincidence Circuit**
**Coincidence Gate Duration**—3 to 1000 μsec.
**Coincidence Amplifier** — may be triggered by either positive or negative pulses in 5-100 volt range.

**Delayed Synchronizing Pulse:**
From cathode follower; positive, over 60 volts, 1 μsec duration.

**Sweep Circuit:**
**Range** — 3, 6, or 12 μsec to 30,000, 60,000, or 120,000 μsec in five decade ranges.
**Accuracy** — ±2%.
**Linearity** — Better than 1%.
**Sweep Repetition Rate** — 0 to 250 kc
**Sweep Duty-Ratio Effects** — Sweep duty ratios up to 50% cause no more than 5% error in slope on shortest ranges, less effect on longer ranges.
**Push-Pull Sweep Output** — Cathode follower, 135v each phase.
**Push-Pull Sweep Gate** — Cathode follower, 40v each phase.

**Push-Pull Pulse Circuits:**
**Pulse Duration Range** — 0.05 to 2.5, 0.05 to 5.0, and 0.05 to 10 μsec, with the 3, 6, and 12 μsec sweeps respectively — five-decade sweep multiplier extends pulse duration to 100,000 μsec; interconnection with delay circuit extends maximum pulse duration to 1.1 sec.

**Pulse Duration Accuracy** — ±(1% + .05 μsec) when sweep is calibrated with "vernier" knob.
**Pulse Repetition Rate**—0 to 250 kc; can be pulsed at 2 to 3 Mc with aid of suitable supplementary trigger generating equipment.
**Pulse Shape** — Rise and fall times (0.025 ± 0.01 μsec) — overshoot and ringing less than 5%.

**Output Impedances:**
50, 72, 94, 150, 600 ohms ±5% — intermediate values obtainable using external resistors.

**Output Voltage:**
150 ma current source into any output impedance from 0 to 600 ohms; voltage equals (0.150 x output impedance) ±2%.

**WE SELL DIRECT**
Prices are net, FOB Cambridge or West Concord, Mass.

## GENERAL RADIO Company

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920 S. Michigan Ave. **CHICAGO 5** — 1000 N. Seward St. **LOS ANGELES 38**

FOR FURTHER INFORMATION CIRCLE 255 ON READER SERVICE CARD PAGE 129

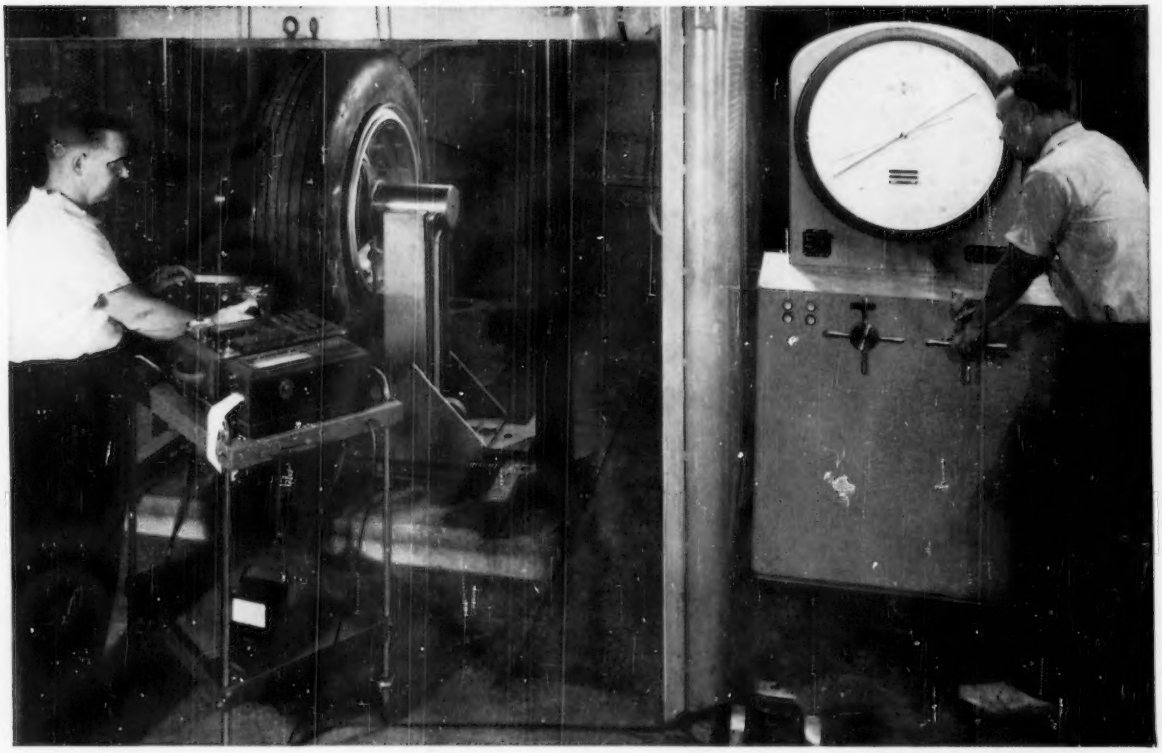

*Photo Courtesy The B. F. Goodrich Company*

# Up to a ½ Million Pound "Squeeze" with an Olsen Super "L" at The B. F. Goodrich Co.

To ensure complete safety, The B. F. Goodrich Company subjects entire aircraft wheel assemblies to tortuous forces of compression far in excess of any encountered in service. The instrument of this "life saving" torture is a 500,000 lb. capacity Olsen Super "L" Compression Testing Machine.

In spite of its size and capacity, this giant Olsen hydraulic machine offers the same operating ease and accuracy of all Olsen Super "L's"—including the SelecTrange Indicating System and a minimum of 50 to 1 spread of testing ranges. With a flip of the SelecTrange switch, the operator can instantly change ranges during test—no need to "calculate" the range capacity beforehand. All ranges have the same zero setting. Loads are clearly indicated on the large, 28-inch illuminated SelecTrange dial. Loading speeds are infinitely variable from zero to the capacity of the machine. These and many other exclusive features account for the unmatched superiority of Olsen Super "L" Compression and Universal Testing Machines.

It will pay you to get the facts about the complete line of Olsen Super "L's". Write today for Bulletin 47.

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FOR FURTHER INFORMATION CIRCLE 256 ON READER SERVICE CARD PAGE 129